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INDUSTRIAL
COMMERCIAL
INSTITUTIONAL AND
PUBLIC BUILDINGS

111 — *Journal Section of the American Society of Heating and Ventilating Engineers*

Four package steam generators modernize 40 year old industrial plant boiler installation. See the article on page 77

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Hanging Pipe?
SUPPORT ALL THE WAY
ADJUSTS AFTER PIPE IS ERECTED
Do it Right!
Wrought Pipe Ring
Steel Band sprung from Recessed Nut.
Cross section showing Locking Feature.

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WHENEVER PIPING IS INVOLVED

THE EDITOR'S PAGES

1947 CONSTRUCTION A PEACETIME HIGH

F. W. Dodge Corp. announced last month that the dollar volume of contracts awarded in the 37 states east of the Rocky Mountains last year was the highest in the nation's peacetime history. It was only 6 percent under the alltime record of 1942, peak year of war construction, and was 4 percent above the dollar total for 1946.

Last year's increase in contract volume did not reflect fully the performance of the construction industry, according to Thomas S. Holden, president of the Dodge corporation. In an interpretative analysis, he pointed out that last year opened with an extraordinary volume of construction projects contracted for and started in 1946 and which were carried over into 1947 for completion.

"Last year," Mr. Holden said, "was marked by a very considerable speed-up in rates of completion of all types of residential and nonresidential projects following the industry's faltering performance in 1946 when strikes in major industries slowed building material deliveries, and various governmental controls and restrictions interfered with the smooth functioning of the industry."

The 1947 total for building and engineering contracts in all classifications was $7,759,868,000, compared to $7,489,722,000 in 1946. Within the over-all increase of $270,000,000, heavy engineering projects accounted for $259,000,000 and combined residential and nonresidential building accounted for $11,000,000. By a narrow margin, residential contracts at $3,153,773,000 exceeded the dollar volume of any previous year. Reflecting the higher construction costs that prevailed in 1947, there was a 14 percent decline from the preceding year in floor area contracted for.

Residential building was marked by a substantial increase in rental housing. Investment commitments for apartment projects amounted to $855,974,000, compared to $486,495,000 in 1946, an increase of 76 percent. In 1947 contracts for public building and engineering projects represented 30 percent of the dollar total, compared with 23 percent for 1946. This increase reflected principally the marked upswing in public engineering projects.

TO KEEP PUBLIC POSTED ON BUILDING INDUSTRY

Formation of the "construction industry information committee," which will undertake to keep the public posted about the performance and progress of the building industry, was announced last month by David S. Miller, president of the Producers' Council.

"The committee will conduct a broad, fact finding program to determine the current status of the building industry in order to keep the public closely informed regarding the progress which the industry is making in meeting the housing shortage and other problems," he said. "It also will provide individuals throughout the industry with a factual basis for correcting erroneous and uninformed statements about the building industry. In addition, it will explain to the public the importance of building activity to the national economy."

BASIC BUILDING CODE OUT FOR REVIEW

The Building Officials Foundation, Rm. 1503, 51 E. 42nd St., New York 17, N. Y., has announced completion of the industry-review edition of the basic building code prepared by the Building Officials Conference of America, Inc., "after three years of intensive work by 70 code experts." Distribution of the code to manufacturers and to organizations concerned with building standards has been started. The arrangement of the basic code follows the recommendations of the American Standards Association, with the addition of articles covering refrigeration and prefabrication.

Joseph P. Wolff, chairman of the board of governors of the foundation, and commissioner of Detroit's department of buildings and safety engineering, reported that industry groups would be allowed until April 15 to review the code and make recommendations to the board of consultants, after which the code would be issued in such form as might be adopted by communities.

The current edition of the code is not designed for immediate adoption by communities. It incorporates functional performance requirements and sufficient mandatory, detailed specifications so that manufacturers, architects, builders, and others concerned are enabled to interpret it.

Mr. Wolff explained that the basic code is "the main service instrument" of the Building Officials Foundation to effectuate national building code reform. The overall objective is to improve the art of building through the elimination of obsolete restrictive codes, to assist communities in the adoption of the functional performance type code, and to provide the machinery needed to keep local codes in step with advances in building.

DETAILS OF NEW YORK MEETING TO BE GIVEN

A short summary of the well-attended American Society of Heating and Ventilating Engineers' 54th annual meeting, held in New York City last month, appears in the ASHVE Journal Section of this issue. The complete "proceedings" of the meeting will be published later.

Some of the technical papers presented at the meeting have already been published in the Journal Section. Others are given this month, and the rest will be printed in future issues.

The 8th International Heating, Ventilating, and Air Conditioning Exposition, sponsored by the ASHVE and which filled Grand Central Palace, was held in conjunction with the meeting and a "preview" of exhibits was published in a special Show Section in our January number. Further details of the new and improved products displayed at the exposition are given, or will be given later, in our Equipment Developments section.

The ASHVE's 55th annual meeting — and the 9th International Heating, Ventilating, and Air Conditioning Exposition—will be held in Chicago the last week of January 1949.

THE EDITOR'S PAGES

PREDICTS MORE COMPACT AIR CONDITIONING

Design trends of the future for air conditioning equipment will be toward lighter and more compact units to save weight and space, in the opinion of A. E. Stacey Jr., Carrier Corp.'s director of application engineering. Speaking before the Washington Society of Engineers, Mr. Stacey also forecast trends toward further increase in efficiency, easier servicing, and greater corrosion resistance.

Reviewing the growth of the air conditioning industry, Mr. Stacey cited five periods of development: basic equipment, starting in 1900; automatic humidity controls, starting in 1906; air distribution, 1910; unit type of air conditioning, 1916; and extended surface heat transfer and centrifugal refrigeration, 1920.

"There is one phase of air conditioning which is not always remembered — formulas and equipment are necessary, but so also is a skill, which in its best form becomes an art, in the application of these developments to any definite requirements," Mr. Stacey said.

"The field of air conditioning covers not only the control of conditions in an enclosure for human comfort and efficiency, but also physical changes in hygroscopic materials and the control of the rate of chemical reactions," he pointed out.

"It must be remembered that air conditioning today is not a new art and that it has been applied to very many types of industry. Fundamentally, it is a tool which may be used in definite and well-known ways, and in agreement with well-known physical and chemical laws," he concluded.

MAIN ST
GIVE

MANDELL HEADS UNIT HEATER GROUP

L. D. Mandell, assistant manager of the C. A. Dunham Co., Chicago, was elected president of the Industrial Unit Heater Association at the group's 22nd annual meeting held in New York last month, and R. H. Nelson, president of the Herman Nelson corp., Moline, Ill., was named vice president of the association.

The secretary-treasurer of the IUHA is L. O. Monroe, 5-208 General Motors Bldg., Detroit 2, Mich.

INDEX TO 1947 ISSUES OF HPAC READY SOON

An index to Heating, Piping & Air Conditioning—and to the Journal Section of the American Society of Heating and Ventilating Engineers —for the year 1947, Vol. 19, Nos. 1-12, will be ready soon and will be available to subscribers without charge on request.

Please advise The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, if you want a copy of this index mailed to you.

HEAT PROTECTS FREEZER INSULATION

A new food freezing plant and a dairy, both in Pennsylvania, have been equipped with a unique system of modified radiant heating to prevent concrete floors from buckling and insulation from disintegrating in freezing rooms and refrigerated storage rooms.

The installations, which make use of wrought iron pipe coils embedded in concrete, were designed by V. C. Patterson & Associates, mechanical engineers, and Buchart Engineering Corp., architects and engineers, York, Pa.

Essentially the same problem was involved at the Adams Apple Products Corp., Aspers, Adams County, Pa., and the Penn Dairies, Inc., Lancaster, Pa. Numerous instances have been recorded where, despite the amount of insulation used, frost has accumulated under the structural slab. In such cases, the insulated floor frequently becomes buckled over a period of time and thus is destroyed. Frosting of the ground underlying the structural slab is the common hazard when low temperatures are employed.

At the dairy and the food plant, the radiant heating systems were installed in approximately the same manner and are similar in design.

The main freezing room in the Adams plant—used primarily for freezing apples, strawberries, etc.—is about 10 ft x 75 ft. An ammonia low temperature, two stage refrigerating system is employed. The structural floor slab, a layer of insulation, and the finish floor slab each are 6 in. thick. In the structural slab, ¾ in. pipe coils were buried during the early stages of construction. The pipes are in the form of a grid and are spaced on 36 in. centers. Similar installations are in the freezing storage room having temperatures ranging from 0 to —5 F, and a freezing tunnel with —30 F temperature.

Instead of using water protected by antifreeze compounds, the designers selected No. 2 fuel oil as the heating medium that is circulated through the coils. The oil is heated to about 40 deg in a small heat exchanger connected to the plant steam lines. The designers estimate that the heat output is sufficient to prevent freezing of the insulation, even when the temperature is reduced to —30 F in the rooms. The heat does not penetrate the finish floor slab, however.

A regular radiant heating system is used at the Adams plant for offices, restrooms, and entrance lobby. This system uses hot water as the heating medium and the 1 in. pipe coils are spaced on 12 in. and 17 in. centers. Closer spacing of the pipe enables the greater heat output per square foot of floor area necessary to establish comfort conditions. A heat exchanger provides the hot water.

C. C. Kottcamp and Son, York, Pa., installed the heating system at the food freezing plant, and Paul E. Gutfleisch, Lancaster, Pa., was the heating contractor for the dairy.

Heating Piping & Air Conditioning

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ublished monthly by the Keeney Publishing Co., 6 North Michigan Avenue, Chicago , Illinois. Telephone: State 6916. Subscriptions: U.S. and possessions, Canada, exico, Central America, South America, 3.00 per year; other, $6.00. Current copies, U.S. and possessions, 35c each; back copies, 0c each. January 1948 issue, $1.50 per opy. Member Audit Bureau of Circulations nd Associated Business Papers, Inc.

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MARCH 1948 . . . . . Vol. 20, No. 3

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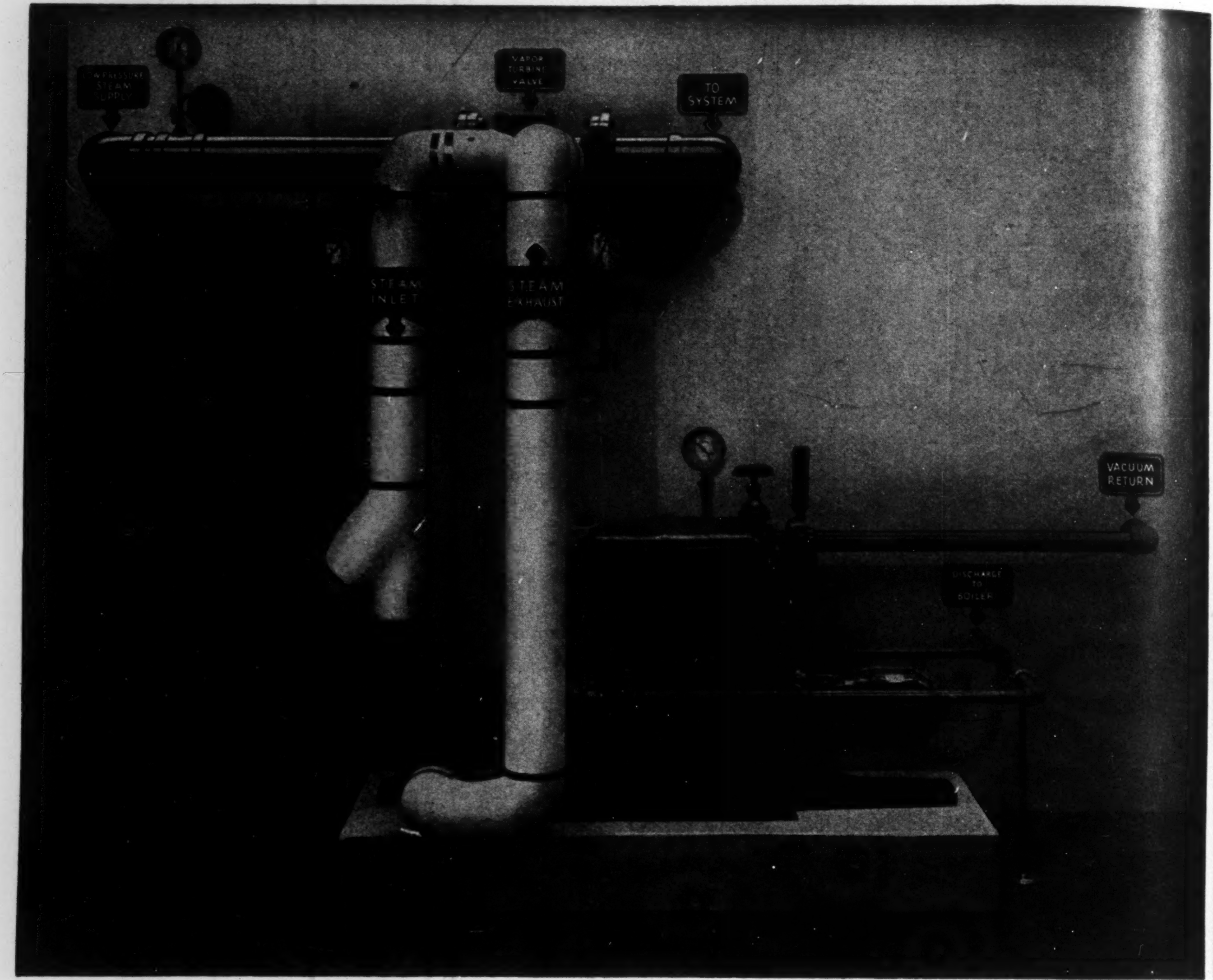
Interrupted Electric Service will not stop this NASH Heating Pump



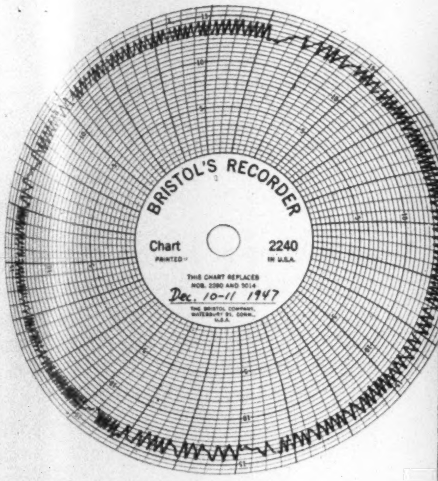
In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is independent of electric current failure, and continues to operate as long as there is steam in the system.

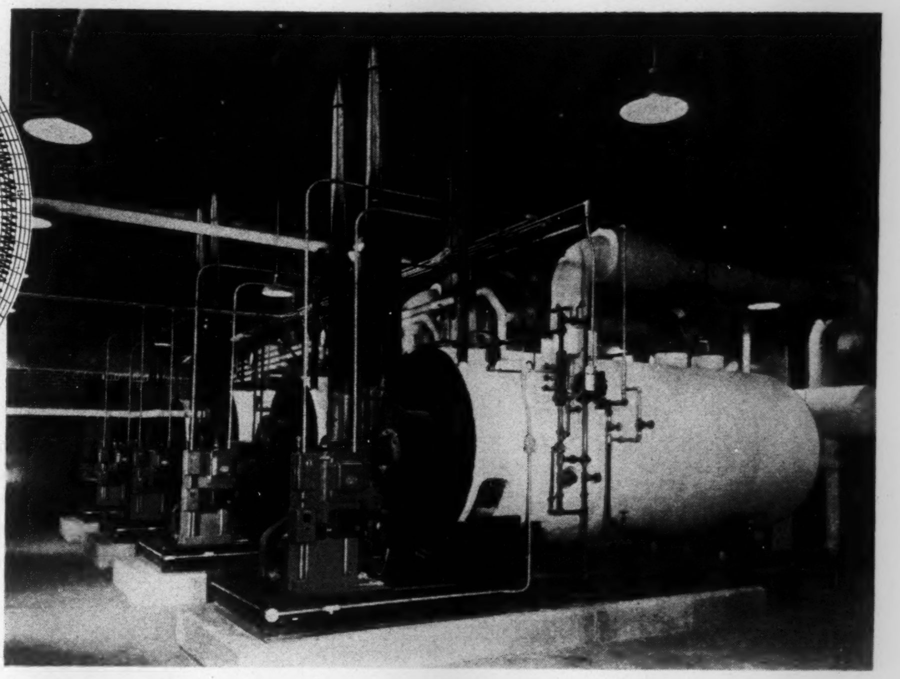
This is because the prime motive power of this economical pump is a special steam turbine, controlled by a unique "Vapor Turbine Valve", which automatically bypasses from the heating main a small portion of steam, the exact amount necessary to develop the power needed to remove the condensate and maintain the required vacuum on the system. Even this small amount is passed immediately back to the mains, and goes on to the system with little heat loss. This pump operates on any system, high or low pressure.

The Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump. Bulletin on request.

THE NASH ENGINEERING COMPANY

205-A WILSON ROAD, SOUTH NORWALK, CONNECTICUT, U. S. A.





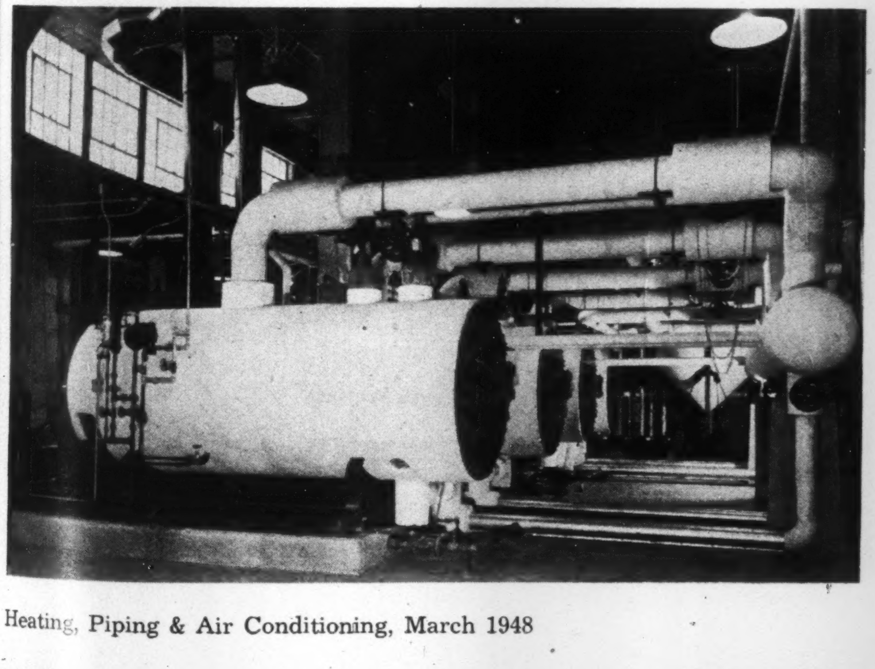
The plant consistently maintains steam pressure between 13 and 14.5 psi gage. This recorder chart is for a normal week day with heavy load. Four 125 hp package type steam generators were selected as being most suitable for the desired type of operation

Packaged Steam Generators Modernize Industrial Plant

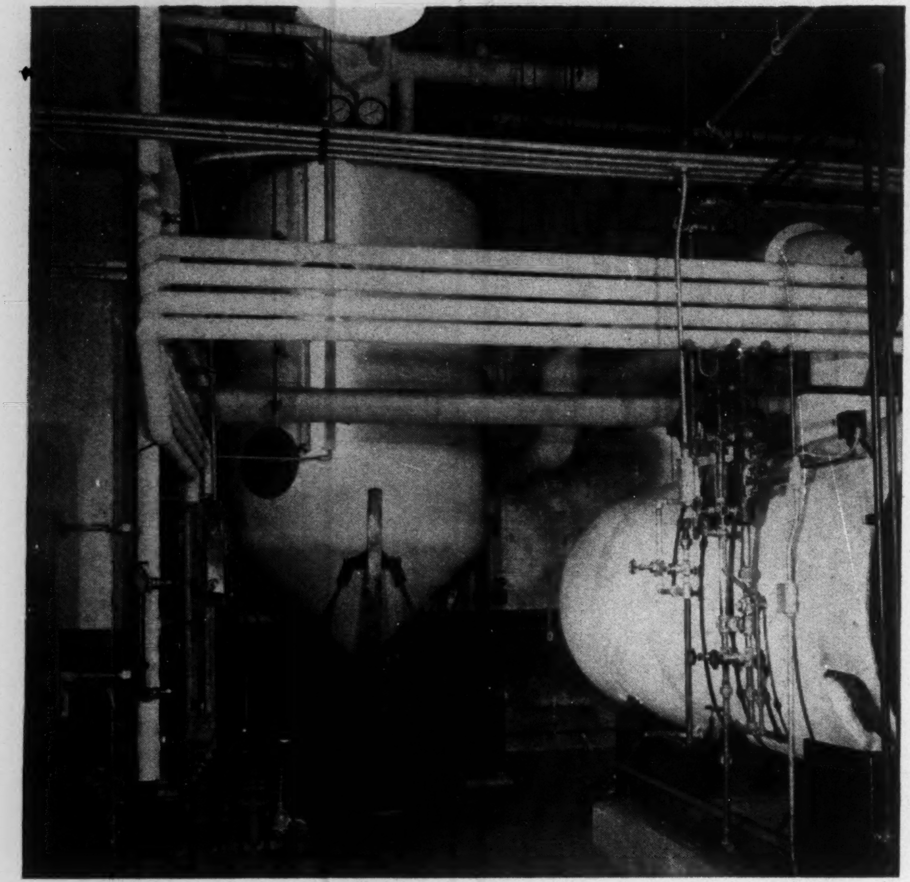
Faced with replacement of a boiler plant which had outlived its usefulness, the Ansonia O & C Co., a 100 year old concern in Ansonia, Conn., manufacturing elastic webbing and braid, and with a quarter of a million square feet of floor space, placed its problem in the hands of Lockwood Greene Engineers, Inc., of Boston, who designed the plant described here.

An investigation disclosed that the labor cost of operating the existing 40 year old boilers amounted to approximately 15 percent more than the fuel cost in any one year.

Development and growth of the company over the years had totally enclosed the boiler plant so that it was not possible to design a new one in the same general location;



RALPH S. FRANKLIN, mechanical engineer, Lockwood Greene Engineers, Inc., Boston, describes here the modernization of a 40 year old boiler installation serving the Ansonia O & C Co. with four package type, oil burning steam generators under sequence control. To increase the water content of the battery as a whole, a 24 in. diameter header about 26 ft long was installed, centered on the water line of the boilers. This header acts as a "flywheel" to counterbalance rapid fluctuations in boiler water level of these units



Water of condensation from process equipment returns through a deaerating heater mounted above a conical bottom receiver which provides capacity for sedimentation, which was believed necessary when remodeling such an extensive installation

there was, however, ample space available in an existing dye house whose use had become unnecessary due to changes in manufacturing procedure. Therefore, it was decided to renovate this area for boiler room use.

Plant management—being particularly interested in reducing costs—recognized that an efficient, well designed, modern boiler plant would result in a saving in both fuel and labor and that a still greater saving could be obtained by a fully automatic plant, which factors determined the design selected.

After the discontinuance of the dye house, the requirements for process steam had materially reduced and it was determined that a continuously maintained steam pressure between 12 and 15 psi would satisfy all production requirements. On this basis, it was determined that a low pressure 15 psi plant would satisfy all requirements and four package type steam generators were selected as being most suitable for the desired type of operation and also for the relation between summer and winter load factors.

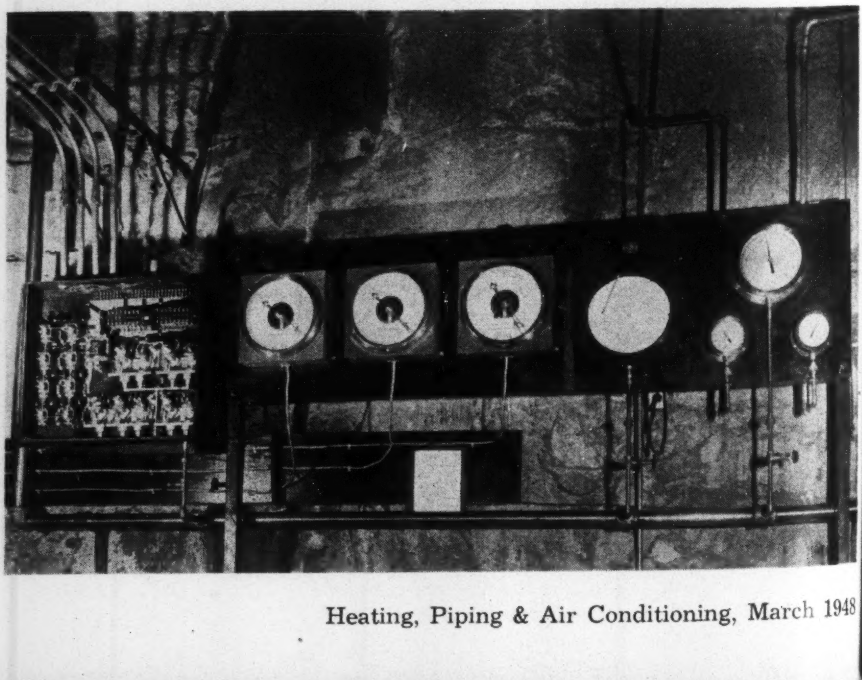
An analysis of the fuel oil situation pertaining at the time, and the assurance of more dependable fully-automatic operation, resulted in the selection of No. 2 fuel oil in spite of its higher cost and lower Btu content.

Pursuing the principle of a fully automatic plant, the method of control of a four unit installation imposed a problem of considerable magnitude as continuity of operation must be assured even though an individual unit should fail, and, further, the control should provide equalization of periods of operation of all units to prevent undue wear on any one of the four.

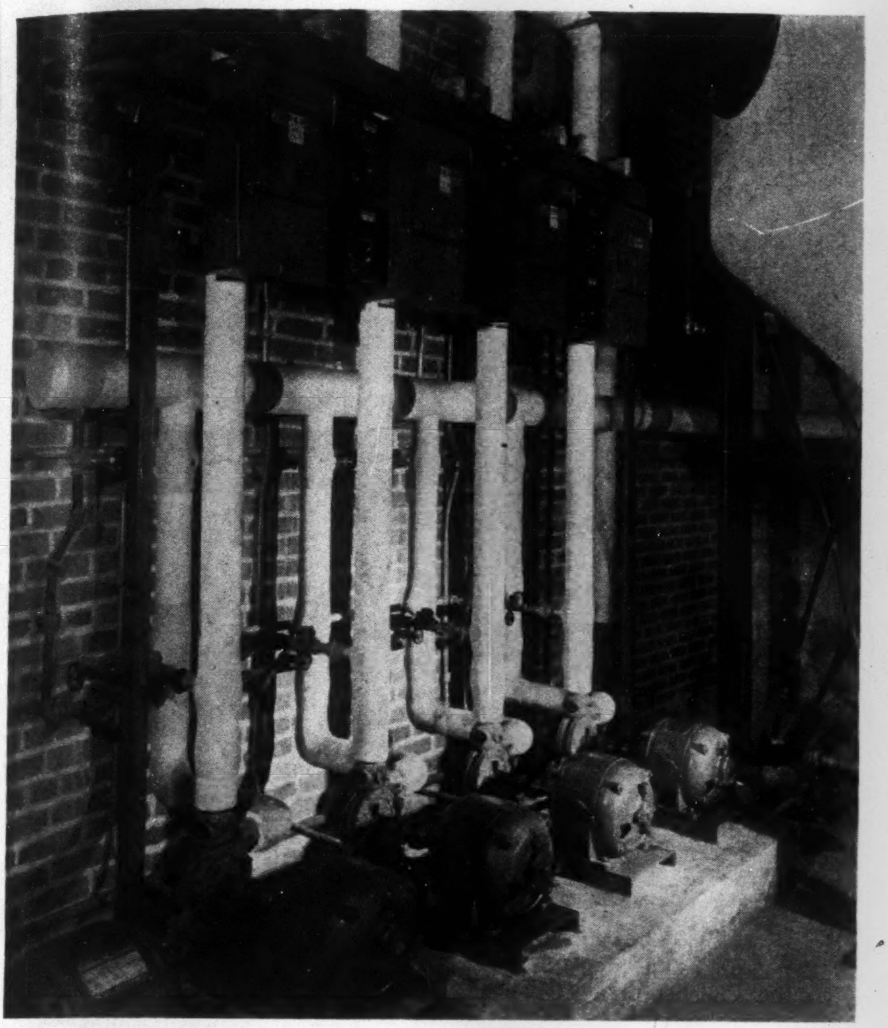
The final solution, which has proved eminently satisfactory in operation, is a form of sequence control which provides definite starting and stopping pressures for each burner through highly sensitive, micromatically adjustable, pressure switches. These switches have been found to be accurately adjustable to a 2 oz pressure difference.

In effect, the plant operates as if it were served by one boiler fired with four separate burners, as all four boilers are kept hot at all times.

During each cycle of operation, a solenoid operated sequence changer transfers the position of leading burner to the following burner, and the leading burner then becomes the fourth burner in line. This transfer occurs once in every cycle, thus assuring uniform operation of each unit. It occurs during the midpoint of the pressure cycle without interrupting the operation of those



During each cycle of operation, a sequence changer transfers the position of leading burner to the following burner to assure uniform operation of each unit. This view of the control board shows, from left to right, the sequence controller (open), three tank gages, steam pressure recorder, heating steam pressure gage, boiler steam pressure gage, and city water pressure gage



Operation of the pumps returning water of condensation to the boilers is actuated by immersed electrode controllers at the water line of each boiler

burners which may be firing at that time.

The type of boiler selected has a very fast steaming rate and a relatively small water content. To increase the total water content of the battery as a whole, a 24 in. diameter header approximately 26 ft long was installed, centered on the water line of the boilers. This header increases the total water volume by approximately 2000 lb and acts as a "flywheel" to counterbalance rapid fluctuations of water level in those boilers being fired. This header also serves as the steam supply header to which the heating and process mains are connected.

Water of condensation is returned from the heating systems by vacuum return pumps and from process equipment by its own pressure through a deaerating heater mounted above a large, conical bottom receiver which provides ample capacity for sedimentation (which was believed necessary when remodeling such an extensive installation).

This water of condensation is fed to each boiler by an individual, direct connected, motor driven pump whose operation is actuated by immersed electrode controllers installed at the water line of each boiler.

In operation, the plant performs satisfactorily and consistently maintains the steam pressure between 13 and 14.5 psi gage.

Attendance has been reduced to one man during regular hours, whose time is spent primarily in keeping the log and cleaning. At night, the plant watchman includes the boiler room in his periodic trips and notes on the log the operating water levels in each unit. He also is instructed to contact the plant engineer by telephone if any unusual conditions occur.

The net results have been an actual saving in fuel cost and a saving in labor cost.

REPORTS SUCCESS OF HEATED DRIVEWAY

A year ago the press gave an unexpected amount of attention to the little engineering adventure at our Bridgeville plant near Pittsburgh, where, in building the entrance driveway, we installed hot water pipes through the concrete to prevent accumulation of snow and ice. In size of installation this seems to have been a pioneer and it is pleasant to record now that the first winter's experience with it, which included one 13 in. snowfall, was a complete success. There was no resort to plows or shovels, the snowflakes melted and evaporated as fast as they fell and the road presented the odd sight under the falling snow of remaining not only clear but dry! It does not take much warmth to melt snowflakes and snow falls rather slowly as a rule and in air temperatures that are not bitterly cold. So nothing extraordinary in the way of heat was necessary and waste factory steam heated the water in the pipes.

The road is two-lane, 16 ft wide and 600 ft long, on a considerable grade with curves, with heavy traffic, and dangerous if icy. It was imperative that the road be kept usable in all weathers. Welded 2 in. wrought iron pipes were run in four pairs following the four logical wheel tracks. The heating system was designed to pump in 50 gpm at an average temperature of 165 F, enough, it was figured, to dispose of snow falling at the rate of an inch per hour, or ice forming at the rate of 0.1 in. per hour, covering all but the rarest conditions in this climate. Wrought iron pipes were used because they are corrosion resistant, they have approximately the same rate of expansion and contraction as the concrete in which they were buried, and they could be bent to follow the curves accurately.

Air vents at the high end were provided to prevent air lock, and drain cocks were installed at the low end. Antifreeze solution was employed; this and a trifle of electric power to operate the pump for circulation when required constitute the only operating cost to provide safe access all winter.—*from a publication of the American Cyanamid Co., as reprinted in the Bulletin of the National District Heating Association.*

When a large hotel was modernized, a major change was in the type of heating units used in the individual suites and rooms. This is a view of one of the modernized suites, showing the under-window installation of a convector

Big Need for Modernization *of Older Heating Systems*

UNBELIEVABLE AS IT might seem today—considering current shortages in materials, fully occupied apartment and office buildings, and full employment of mechanics on new construction—the time will come some day when "apartment for rent" and "office on attractive terms" signs will reappear and new construction will be insufficient to absorb "100+percent" of the available mechanics and supplies of equipment.

There is a huge replacement market awaiting development in the heating field, and with the cooperation of manufacturers and contractors the level of heating installations in many economically sound older buildings can be raised to that of the newer structures.

There are many hundreds of walk-up three, six, 12, 24, and larger apartment or flat buildings as well as office and institutional buildings that are from 20 to 50 years old. Almost all of these buildings have been modernized in decoration. They have had plumbing fixture replacements, new refrigeration equipment, and other modern appointments. But few have modernized heating systems. And, certainly, the technological advances in heating within the last decade make obsolete most of even the good systems of the 20's and early 30's.

These structures often are characterized by uncontrolled heating systems. Occupants either roast or freeze in continued cold weather, for the systems were designed for maximum heating output at low outdoor temperatures, and the only control in mild weather is to have intermittent operation of the system.

Common practice is to leave the radiator valve open in order to have sufficient heat at all times; then, when temperatures get too high, to open the window. Every one of the Btu's that goes out the window is coming from costly fuel. And open windows cause drafts and result in a generally unsatisfactory condition to the occupant. With today's know-how on heating, there is no reasonable excuse for such conditions to exist.

There is no more reason for the public to accept obsolete heating equipment in living and working spaces than there is to expect it to accept obsolete plumbing or out-of-date refrigeration. After all, the heating system is the key to comfort in any space, and the primary requisite for comfort is a constant

GEORGE M. FRASER suggests here the replacement of obsolete types of heating systems in apartment, office, and institutional buildings with modern, controllable equipment. At the present time—with building space at a premium, and shortages in materials and labor—action as suggested is perhaps not essential. When apartment and office space is again more easily available, tenant preference will be for the spaces providing the most comfort.

supply of heat in the right quantity to balance the natural heat loss from the body.

On some types of old heating systems, replacement with small floor or wall mounted convectors with built-in dampers will greatly increase the controllability of the heating units, for in very mild weather, with a closed damper, approximately 10 percent of the rated capacity of the unit is available as radiant heat. Only that amount of heat will be extracted from the steam or hot water passing through the convector and fuel will be economically utilized. As heat demand increases, the damper can be opened and the supply of heated air increased as required.

On other old systems, conversion to forced hot water may be highly desirable, and with the use of small tubing or piping this can be accomplished with a minimum of disturbance to the structure. Again the floor or wall cabinet convector is an ideal unit for such modernization for it, too, can be utilized without change to the structure. Its small overall size, and smooth, trim, surfaces, plus the fact the furniture can be placed practically in contact with the heating unit without harm, permits freedom in interior decoration.

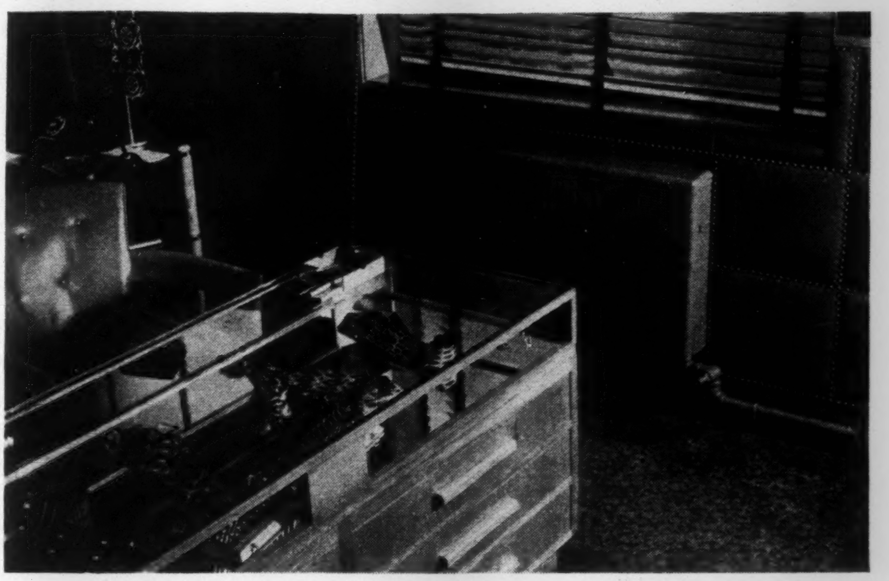
Major Campaign Practical

A major modernization campaign is practical. A survey of real estate operators of apartment and office buildings in one large city has indicated a lively awareness of the heating problem. They realize that heating has been brought forcibly to the attention of the public through spectacular gains in air conditioning of public spaces and through the numerous promotional programs of various proponents of modern heating systems.

Under present conditions, with space at a premium and materials in short supply, action is not essential, perhaps, at this time. Inasmuch, however, as most of the buildings erected in the last 10 years have been equipped with modern controllable heating, there is little question that when apartment and office space again is available, tenant preference will be for the spaces providing most comfortable conditions, and with units which are smart and modern in appearance.

There is another angle to improving apartment and commercial heating systems. A high percentage of people base their judgment of a method of heating on their experience with the systems they have been exposed to in rental units. When these people go into the market for a new home, their "heating decisions" are very much affected by this experience.

It is to the interest of all factors in the heating business to push modernization of obsolete heating systems. Whether such modernization is a replacement involving a single modern convector, or the conversion of an entire system from an uncontrollable, costly method to a fully controllable modern system, it should be encouraged. We must educate the public to think in terms of modern heating systems instead of obsolete systems.



In a downtown office building, new convector radiators replaced older heating equipment as a major factor in the modernization of tenant space. Here, a modern wall-hung convector is shown against the leather covered walls of a beautifully decorated necktie shop.

ELECTROLYTIC FILM DETERMINES MOISTURE

An improved method for measuring small amounts of water vapor in gases has been developed by E. R. Weaver of the National Bureau of Standards, Washington, D. C. This procedure, which may also be extended to the determination of the moisture content of certain liquids and solids, depends essentially on the change in electrical resistance of an electrolytic film as it absorbs water vapor.

Such a method has the advantages of speed, simplicity, high sensitivity, and wide range, and is very flexible in operation and is readily adapted to numerous applications, such as measuring the moisture-permeability of membranes, detecting minute concentrations of combustible gas in air or of oxygen in combustible gas, determining water vapor in aviators' oxygen or in liquid carbon dioxide, measuring the capacity of drying agents, determining the water content of organic liquids and solutions, and measuring the relative humidity in small or comparatively inaccessible spaces under rapidly changing conditions, according to the bureau.

The principle of the method has been employed at the bureau in various devices for some time. A thin film of liquid, which may be phosphoric acid or a solution of sulfuric acid or other electrolytic compounds in a gelatin or plastic binding material, is spread over the surface of a solid insulator between metallic electrodes. The electrolyte tends to reach equilibrium with the water vapor in the surrounding gas and to form a solution the electrical conductance of which is a measure of the concentration of water vapor in the gas. To utilize this phenomenon, some sensitive instrument for measuring or comparing electrical resistances and a means of calibrating the film by comparison with a gas of known moisture content are necessary. Because of polarization, alternating current must be used.

THE HEAT PUMP

How to Analyze Earth as a Heat Source

By B. F. Raber, C. F. Boester, and F. W. Hutchinson

DUE TO GROWING interest in the heat pump, a comprehensive program of analysis and research in this field has been formulated by the authors and is already underway. Two full-size heat pump installations are now complete and ready for detailed experimental study.

This paper is the first publication from the project and deals entirely with the analytical determination of limiting conditions for estimating the practicability of using the earth as a receiver of heat in summer and a source of heat in winter. Subsequent publications from this project will develop equations derived particularly to meet special conditions associated with heat pumps, but the present paper is intended to show the applicability to idealized heat pump systems of fundamental equations from the general literature on heat transfer.

A generalized graphical solution is presented of the basic equation which establishes a boundary design value of the heat transfer rate, for either summer or winter operation, of unit area of a large earth-embedded flat plate; the solution is developed in such a manner that no calculations nor resort to equations is necessary and an approximate boundary solution to practical flat-plate problems can be obtained directly from the graph in terms of known properties of the earth in the particular locality.

Thermodynamically, a heat pump raises the availability of a large quantity of energy by adding a small quantity of energy (as shaft work) which possesses maximum availability. Just as a large quantity of water at low level can be raised to higher level by application of shaft work (at the pump) so too can the temperature level of low temperature energy be raised through the addition of shaft work. The ocean, for example, possesses a very large quantity of heat (strictly, internal energy), but its intensity—as measured by temperature—is very low; in order to use the ocean's heat, some means would be required for pumping this heat to a higher temperature level. The heat pump provides such a means and it operates to pump heat out of an occupied space in summer and into such a space in winter.

Heat Pump Requires Source of Heat

The fundamental requirement of any heat pump is, therefore, a source of heat in winter and a receiver for heat in summer. A second requirement—dictated by the need for operating economy — is that the heat source be at the highest obtainable temperature level and the heat sink at the lowest obtainable temperature.

Among the sources and sinks proposed for heat pump use have been atmospheric air, large bodies of water, large ice masses, wells, and the earth. The first three of these would be used under conditions such that the energy received or discharged by the heat pump would have no appreciable influence on the subsequent temperature of the source or receiver—hence the problem of heat transfer would be essentially one of steady state equilibrium conditions with fixed temperature difference between the transfer surface and the surround and hence fixed capacity (or rating) of the transfer surface. The design procedure for such a system would not appreciably differ from that commonly used for other steady flow types of air conditioning or refrigeration transfer surfaces.

In the case of the fourth possible source, well water, the situation is somewhat different since movement of underground water through a well may not be at a sufficiently rapid flow rate either to supply or remove heat as fast as it is transferred to or from the transfer surface of the heat pump. If this is the case, the temperature of the well water would necessarily rise in summer and fall in winter and if the transfer surface were operated at fixed temperature throughout either season the capacity of the surface would progressively decrease as the season progressed. This could, of course, be overcome by altering the transfer surface temperature with time, but only at the cost of lowered operating economy. For wells of moderate size in earth which is reasonably porous, the problem of water temperature rise or fall (due to heat pump operation) is frequently not severe and one highly favorable fact is that convection currents in the well water can be counted on to maintain practically uniform temperature in the well and thereby definitely fix the change in surface-to-water temperature difference as a function of the mass of water present in the well; thus the rating of the transfer surface can only vary as rapidly as the temperature of the *entire* mass of well water varies.

Earth As a Source or Sink

When earth is used as a heat sink or source, the situation is very different from that in the cases considered above. With air or water, convection practically eliminates gradients of temperature in the main body of sink or source and with melting ice or freezing water uniformity of temperature is assured. But when earth receives or gives up heat, the thermal resistances are such that marked temperature gradients will occur through the mass.

For a transfer surface embedded to a depth of 10 ft or more, the seasonal influence at the earth's surface on heat pump operation will usually be so slight as to have no practical significance; in the limiting case of a very deeply buried surface, equilibrium would never be reached (because of the seasonal periodicity) and hence there would be no possible means of attacking the problem in terms of the usual steady state concepts. From another standpoint, the earth surrounding the transfer surface acts as a low efficiency insulant which, as it slowly increases in temperature, more and more effectively reduces the rate of heat dissipation from the heated or cooled surface. Thus, a hot pipe, for example, if suddenly buried in cool earth would lose heat at a rapid initial rate, but this loss would rapidly decrease with time and would asymptotically approach zero at infinite time; actually the rate of decrease of loss is so rapid that even after a relatively short time the pipe heat loss would be very low.

Consideration of the earth as a sink or receiver for heat pump service thus requires readjustment of the usual design concepts as used for water or air and substitution of a transient analysis in place of equilibrium analysis. The problem thereby becomes vastly more complicated than for other cases, but the complication cannot be avoided if adequate accuracy and effective design is to be achieved. Time is the essence of design in all earth-embedded transfer surface design problems and any solution which does not take account of time may be dangerously incorrect. This fact can be readily demonstrated by noting (as will be shown in later discussion) that if a large flat plate at 85 F were buried in earth uniformly at 50 F the rate of heat loss from the plate would be 19.65 Btu per hr per sq ft at the end of the first hour, but would drop to 4.91 Btu per hr per sq ft at the end of 6 hr and to approximately 1/3 Btu per hr per sq ft at the end of the five month (3600 hr) cooling season. Thus, it is very evident that any statement as to the heat transfer rate from such a buried plate is essentially meaningless unless the rate is given as an instantaneous one applicable after a specified number of hours subsequent to initial operation.

6000 Percent Change in Rating

In summary, the heat transfer from or to plates embedded in earth is characterized by a transient condition which causes the rating to decrease with time. That this factor is of practical rather than merely academic interest is demonstrated by the fact that the change in rating of the plate considered above —over a five month cooling season —is of the order of 60 to 1, almost 6000 percent.

Considering the seasonal periodicity of earth as heat sink or heat source, the problem bears striking resemblances to that of a simple regenerator, the principal difference being that the quantity of energy supplied by the pump to the earth during the summer is usually less than that taken from the earth during the winter—hence, the surrounding earth must supply a net quantity of heat to the system annually. The regenerative concept, however, is encouraging in that it permits treatment of the problem by the same methods used with regenerators as applied in the process industries. Here again, the concept of time as the most important

THE USE OF EARTH as a heat sink or heat source for heat pump operation requires very different methods of analysis from those used when the atmosphere or a large body of water or melting ice (seasonally freezing water) are used. For air, water, or ice the transfer to or from the medium does not alter the temperature of the medium—hence steady state, or equilibrium, methods of analysis can be used. When heat is added to or extracted from the earth, however, the diffusion of energy occurs so slowly that marked temperature gradients are established and these vary as a function of time. Hence earth-embedded heat transfer surfaces *must* be designed in terms of transient heat flow if they are to perform satisfactorily over the extended period (five months or more) of either the heating or the cooling season. Further, the importance of transient analysis is brought out from the fact that variation in heat transfer rates with time are of the order of thousands of percent; hence, the difference between conventional steady state design procedures and transient procedures is one of paramount practical importance.

As a corollary of the above discussion, experimental work on transfer rates from or to embedded surfaces must be carried on over a time period of the same order of magnitude as that which will occur in the actual installation. Adequate design data for embedded transfer surfaces for heat pump use cannot be obtained from tests of duration less than three months since the greater transfer rates that occur early in the operating period will have undue influence on the average rate and this will appear much higher than the value likely to be found over a typical five month season.

A general graphical solution is presented for determining the instantaneous transfer rate from one side of a very large buried plate at any given time after it is buried. The same graph is extended to permit addition of scales giving the total quantity of heat transferred from one side of the plate during the interval from start-up to any later time. The rate or quantity for both sides of the plate can, of course, be obtained by multiplying the graph values by two.

The solution and the graph given in this paper are for an idealized system, but for one which is believed to give design values that are conservative. Analysis and experiment are now underway on a comprehensive heat pump research project and results will be published in subsequent papers.

The authors are, respectively, professor of mechanical engineering, University of California, Berkeley; housing research consultant, Purdue Research Foundation, Lafayette, Ind.; and professor of mechanical engineering, University of California, and consulting professor of mechanical engineering, Purdue University.

single factor in design becomes evident.

Non-Flow Boundary Condition

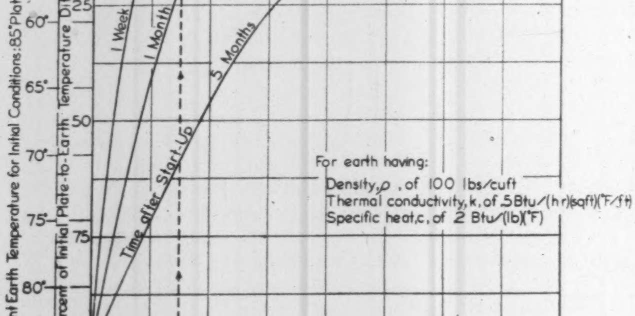
The above discussion is applicable to dry earth or to earth containing any degree of moisture up to saturation, but subject to the condition that there is no flow of water through the earth spaces. In many actual installations the water table will be so high that convection in the fluid will more rapidly equalize temperatures than the dry earth thermal diffusivity would indicate as likely and in other cases a flow of water across the transfer surface will nullify the expected transfer rate, but—in general—the rate of heat transfer from or to the plate will vary as a function of the earth's thermal diffusivity. In terms of design, fluid flow across the plate cannot usually be assumed, hence a conservative (but reasonable) design assumption is that which considers that transfer is based on the assumed moisture content, but is considered as occurring under conditions for which no actual fluid flow across the plate occurs. More favorable conditions than these will doubtless occur at intervals throughout the season, but the surface must be designed to handle the most severe conditions that will normally take place and these are represented by the dry (or non-flow) soil concept.

As the moisture content of the soil increases the thermal conductivity, density, and specific heat likewise increase, but the rate of plate heat loss obeys the same equations up until such time as definite flow (that is, convective heat transfer) occurs across the transfer plate—hence the criterion of departure from the fundamental equations is movement of the water with respect to the soil lattice rather than quantity of water present. The analyses covered in this paper are, without exception, based on the non-flow concept; thus, if actual flow of water with respect to the soil lattice does occur, the results presented herewith will be unduly conservative, but since flow can rarely be assumed as occurring during design conditions, the non-flow results are likely to be of greatest practical applicability.

Non-flow equations have been developed for a number of special cases. Thus, for a heated or cooled hollow cylinder immersed in material (as earth) of uniform temperature, Perry and Berggren* develop a method based on the graphical solutions of Nessi and Nisolle** which could be applied to a condenser or evaporator tube of a heat pump installation. For a tube embedded below the earth's surface but sufficiently near it so that at equilibrium there would be an appreciable transfer rate equations are available in the Boelter-Cherry notes*** which can be used for determination of the equilibrium value of the rate of heat transfer.

Of most direct applicability, however, is the analysis developed for a sudden temperature change of one surface of an infinite solid. This limiting condition corresponds to that which would exist if a flat plate of infinite surface area were embedded in the earth at sufficient depth to eliminate surface effects and if the plate were then maintained at any fixed temperature other than that of the uniform earth temperature at time of plate embeddment. In effect, this idealization is applicable to a flat plate of finite area subject to the assumption that heat flow to-or-from it is unidirectional; that is, end effects are considered negligible.

Fig. 1—The influence of a plate temperature substantially different from the initial earth temperature is not observed far from the plate except after long time intervals, as can be seen in this solution of Equation 1 for a particular case



Infinite Plate Embedded in Infinite Solid

The fundamental equations for this case are given on pages 32-33 of Schack† and the derivations are presented on pages 33-37 of the same reference. Changing nomenclature in accordance with accepted American standards, the equation for temperature in the earth at distance x from the transfer plate after θ hours of operation is given by,

$$t_x = t_p + (t_e - t_p)\ f\left(\frac{x}{2}\sqrt{\frac{\rho c \theta}{k}}\right) \quad [1]$$

where ρ, c, and k are density, specific heat, and thermal conductivity of the earth; t_x, t_p, and t_e are the temperatures at point x out along a normal from the plate θ hours after start-up, the fixed plate surface temperature, and the initial earth homogenous temperature, respectively; and $f(\ )$ is the Gauss or probability function and is evaluated in tabular form in a number of standard references, as Pierce' Table of Integrals.

Fig. 1 shows a solution of Equation 1 for the particular case of earth having a density of 100 lb per cu ft, thermal conductivity of 0.5 Btu per hr sq ft per degree Fahrenheit per ft, and specific heat of 0.2 Btu per lb per degree Fahrenheit. As evident from the figure, the influence of a plate temperature substantially different from the initial earth temperature is not observed far from the plate except after long time intervals; thus, after one week the effect of a plate 35 F different from the earth temperature is experienced approximately 10 ft from the plate, while even by the end of the cooling season (five months) there is no appreciable effect on the earth more than 40 ft from the plate. Further observation of Fig. 1 shows that unit area between the ordinate for zero distance and the curve for a given time is proportional to the quantity of heat entering storage in the earth; examination of the figure clearly shows that the energy entering storage between the first and fourth week is not appreciably greater than that entering storage during the first week, hence there is a very rapid falling off of the quantity of transfer from the 85 F plate to the surrounding earth.

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*Perry and Berggren: Transient Heat Conduction in Hollow Cylinders after Sudden Change of Inner-Surface Temperature. University of California Publications in Engineering, Vol. 5, No. 3, pp. 59-88, 1944.

**Nessi & Nisolle: Methodes Graphiques pour l'etude des Installations de Chauffage et de Refrigeration en Regime Discontinu. Dunod, Paris, 1929.

***Boelter, Cherry, and Johnson: Heat Transmission Notes. University of California Press, 1947.

†Schack, Goldschmidt and Partridge: Industrial Heat Transfer, John Wiley & Sons, 1938.

Instantaneous Heat Transfer Rate

Recognizing the rapid falling off of rate of heat transfer from the plate as a function of time, Schack gives the equation for the instantaneous heat transfer rate from the plate at time θ as,

$$q_p = 0.567 \frac{\sqrt{\rho c k}\ (t_e - t_p)}{\sqrt{\theta}} \ldots [2]$$

and the total heat transfer from start-up to later time θ as

$$Q_t = 2\ \theta q_p \ \ldots\ldots\ldots\ldots\ldots [3]$$

where q_p and Q_t are, respectively, the instantaneous transfer rate from one side of a buried plate of unit area and the total transfer, Btu per sq ft, from one side of the plate during the θ hours from start-up. A fictitious transfer rate representing average conditions over the θ hour period can be obtained by dividing Q_t by time; hence—from Equation 3—the average rate of transfer from one side of an embedded plate during θ hours is numerically equal to twice the instantaneous rate at the end of the same time interval or,

$$q_{p\,av} = 2\ q_p \ \ldots\ldots\ldots\ldots\ldots [4]$$

Fig. 2, developed for the same earth conditions as Fig. 1, shows the rapid falling off of q_p as a function of time and thereby emphasizes the need for reporting heat pump experimental results in terms of seasonal performance rather than for brief test periods. By observation from Fig. 2 the instantaneous and average rates as determined by a test period of one week would be 1.5 and 3.0 Btu per hr per sq ft for loss or gain from one side of the plate, whereas rates obtained from a full seasonal test of five months would be 0.33 and 0.66 Btu per hr sq ft for the respective instantaneous and average conditions. Thus, if imbedded surfaces were designed from the one week data the surface area might be only 22 percent of that actually needed for seasonal operation.

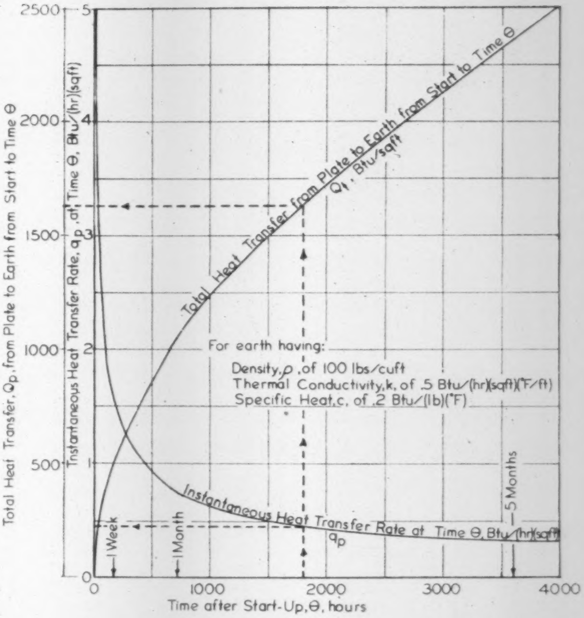


Fig. 2—The rapid falling off of the instantaneous heat transfer rate as a function of time is shown here. This figure is plotted for the same earth conditions as was Fig. 1

In using the average transfer rate, the designer must bear in mind that surface area sufficient to give the required total seasonal transfer will give an instantaneous transfer rate at season's end which will be only 50 percent of the average. Since load on the system normally falls off near the end of the season, this fact is not of great importance, but what is vitally significant is that a transfer rate many times that of average must be maintained at the beginning of the season if the total seasonal transfer is to be achieved with the design area of surface. But at the start of the season, load is normally low and hence high transfer rates cannot be justified and, in practice, the temperature of the embedded plate (acting as evaporator or condenser) will necessarily be maintained at a value closer to that of the earth than will be the case later in the season. Because of this, the required surface area for seasonal operation will be greater than the average seasonal transfer rates would indicate. Hence the idealization of a large embedded flat plate is useful in giving a conservative evaluation of overall conditions for seasonal operation. Although the equations are written in terms of a plate temperature lower than that of the surrounding earth, it will be readily evident that they are equally applicable to the heating as well as the cooling cycle.

Another limitation of the flat plate concept is that it assumes unidirectional heat flow. For very large plates, this would be a reasonable approximation but for small plates there will be a greater rate of heat transfer because of flow of heat out into the earth areas at the ends. Again, however, departure of the real from the fictitious system is in the direction of greater capacity so use of the infinite plate concept will give a conservative approximation.

Graphical Solution of Equations

Fig. 3 is a general graphical solution of Equations 2 and 3. As an example of its use, consider the following problem: A very large flat plate is embedded in earth having a density of 100 lb per cu ft, a thermal conductivity of 0.5 Btu per hr pr sq ft per degree Fahrenheit per ft, and a specific heat of 0.2 Btu per lb per degree Fahrenheit. The earth is initially at a uniform temperature of 50 F and the plate is suddenly heated to 85 F and maintained at this temperature for three hours. At the end of this time, determine the instantaneous rate of heat loss and further determine the total amount of heat which left the plate during the three hour period.

Solution: Enter Fig. 3 at the lower left at a density of 100 and rise (see dotted example line) to intersection with the 0.5 conductivity line, then move right to intersection with the 0.2 specific heat line and rise to intersect the curved reference line in the upper left quadrant. From this intersection

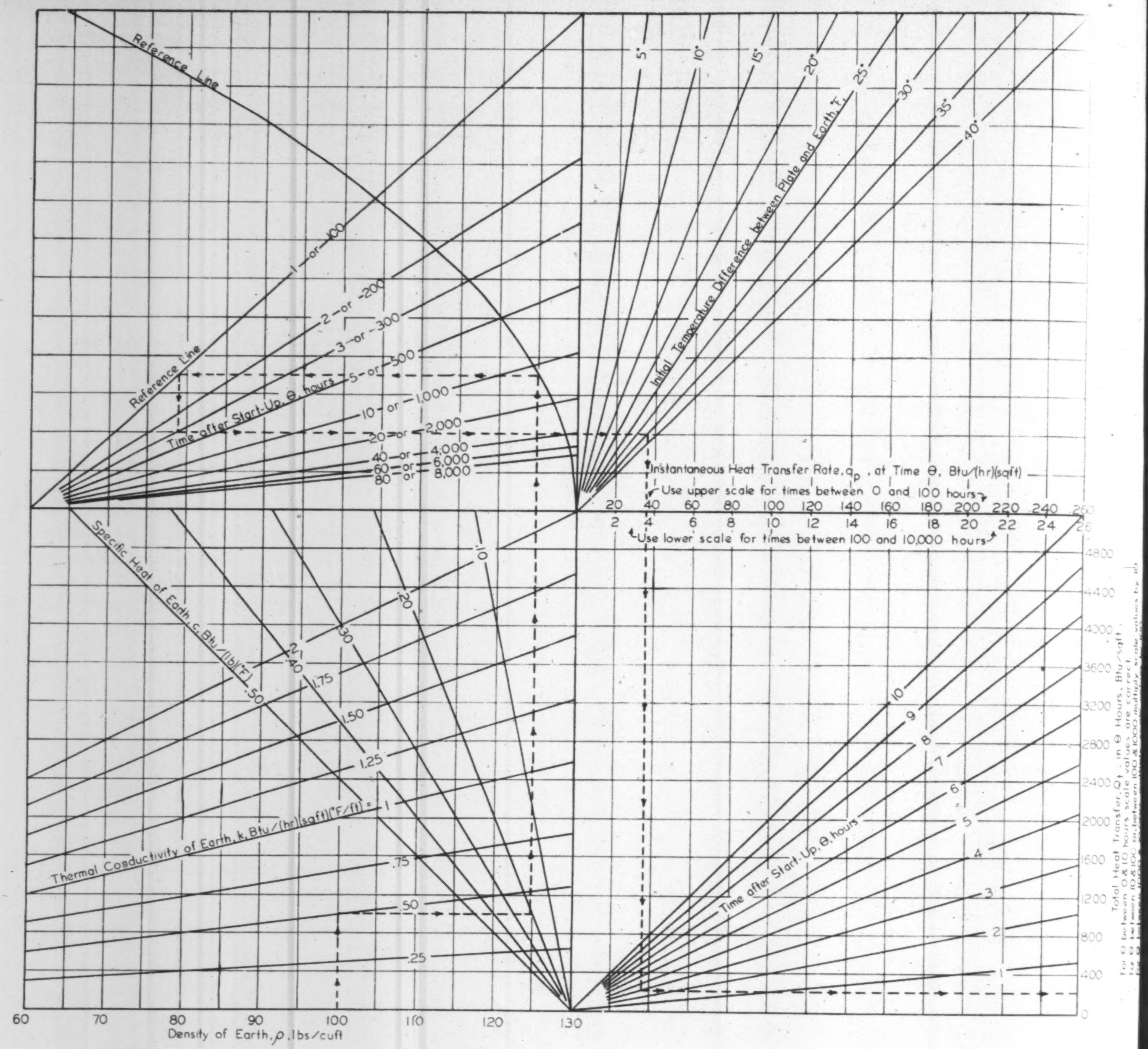


Fig. 3—This is a general graphical solution of equations given in the text; an example of its use is also given in the text

move left to meet the diagonal reference line and then drop vertically to the radial line corresponding to a time interval of three hours. From here move right to the upper right hand quadrant where intersect the radial line for an initial temperature difference between plate and earth of 85—50 = 35 F and from this point drop to the instantaneous heat transfer scale where read the rate at end of three hours as 36 Btu per hr per sq ft from one side of the plate. The transfer rate for the plate as a whole (assuming loss from both sides) is then 72 Btu per hr per sq ft. The quantity of heat lost during the three hour period is now found by dropping from the instantaneous scale down to intersection with the radial line for time equal to 3, then moving right to intersect the total heat scale where the answer is read as 216 Btu per sq ft from one side or 432 Btu per sq ft considering both sides.

In using Fig. 3, note that the time lines in the upper left quadrant are valid for either 1 to 80 hr or 100 to 8000 hr. When the time is less than 100 hr, the upper scale for instantaneous transfer rate (upper right quadrant) is used, whereas for time between 100 and 10,000 hr, the lower scale is to be used. The radial time lines in the lower right quadrant are valid for any time interval up to 10,000; thus the line marked 6 can be used for 6 hr or 60 hr or 600 or 6000 hr and the corresponding answer would be determined from the total heat transfer scale with a multiplying factor as shown in the notes below the scale.

620 MILLION TONS OF COAL

A new record production "of at least 620,000,000 net tons" of bituminous coal was mined in 1947, according to the Bituminous Coal Institute, exceeding slightly the exceptional wartime output of 1944. In addition to supplying the extraordinary U.S. domestic needs, some 42,000,000 net tons of U.S. bituminous coal was exported (excluding Canada).

ALUMINUM PIPING

Where and Why It's Used

JUST A FEW years ago the piping engineer's choice of materials was largely limited to piping and components made of cast iron, carbon steel, a few alloy steels, wrought iron, copper, and brass. Today, as a result of metallurgical research, a surprisingly large number of piping materials is available, among them intermediate and high alloy steels containing chromium or nickel, or both; commercially pure nickel, nickel-copper and nickel-chromium alloys, and aluminum and aluminum alloys

In the past two years considerable information has been published in the technical press dealing with applications where stainless steel piping can be used to advantage, and how it can best be assembled. But little similar data have appeared about aluminum and its alloys, although of the newer materials previously cited, they stand next to, or perhaps are on a par with, stainless steel in usefulness for industrial piping. So it is the purpose of this and a subsequent article to supplement the generally meager knowledge of the value of aluminum piping by discussing 1) where aluminum and aluminum alloy piping may be used, 2) aluminum piping design precautions, 3) the chemical and physical properties of the materials, 4) code requirements and allowable working pressures, 5) the availability of aluminum and aluminum alloy piping components, and 6) methods of fabrication suitable for aluminum piping systems.

The vast chemical industry, and industries that use chemical processes, present many challenging problems to piping engineers. There are corrosion, catalytic, and physical problems. There are problems relating to temperatures, which range from very low to very high; problems brought about by temperature variations, and problems of various other kinds. All of them are of major importance and demand painstaking analysis of the metals available for construction purposes.

Those who have closely studied the modern alloys that have been developed to meet severe service conditions have a clear understanding of the advantages and the limitations of each, and the proper appreciation of the applications to which each is best suited. They have found that in some services one of several metals can be satisfactorily used to meet the same problem, and they have learned to make their selection in the light of the cost and fabricating problems involved.

C. B. McLaughlin, head, engineering service division, Tube Turns, Inc., explains why aluminum alloys are important piping materials for many industrial applications such as those found in chemical, food, soap, cosmetic, and petroleum plants. Noteworthy properties of these metals are discussed and design precautions with respect to galvanic action, flexibility, insulation, gaskets, hangers, and supports are given. A subsequent article will cover code requirements for piping design, fabricating techniques, and aluminum alloy piping components which are available.

Why Aluminum Is an Important Piping Material

Although aluminum and its alloys have been generally available since 1920, it is only recently that their many merits have been widely recognized and utilized. Among the advantages they offer are high strength, light weight, good thermal conductivity, resistance to corrosion, passivity when in contact with numerous corrodents, and absence of sparking characteristics—all of which deserve consideration in setting up specifications for piping materials. It might be well to point out here that the most popular sizes in aluminum piping are from ⅜ to 6 in., according to a recent survey. The survey also indicated that some requirements call for sizes up to 12 in. and that the chemical industry, equipment manufacturers, and pipe fabricators are the largest users.

There are four outstanding factors which make aluminum an important piping material. Before considering the applications for which aluminum piping is suitable, a brief statement of these factors will be of value since they are frequently involved when process piping engineers are endeavoring to select the most suitable material.

These factors are:

1. It has excellent corrosion resistance to a great many fluids
2. The products resulting from mild corrosion of aluminum by the fluid being handled are colorless and nontoxic
3. Pipe, fittings, flanges, and valves are readily available
4. In relation to other corrosion resisting materials it is very low in initial cost.

While aluminum pipe costs approximately twice as much as carbon steel pipe, its price is only about ¼ as much as copper or copper alloy pipe, and 1/7 as much as stainless steel pipe of the same wall thickness. Even if the stainless pipe thickness is reduced to one-fourth that of standard weight or 0.072 in., the cost per hundred feet is still nearly twice that of aluminum pipe having a wall thickness of 0.280 in. In view of the differences in weight, all price comparisons with aluminum should be made using prices per foot rather than prices per pound.

Aluminum Piping Has Many Applications

The fields in which aluminum piping is being used may be classified under five general headings, chemical plants, food plants, soap and cosmetic plants, petroleum plants, and irrigation.

Chemical Plants: Aluminum already has a position of growing importance in the chemical industry because of its corrosion resistance to the following:

Distilled water
Formaldehyde
Glycerine
Acetic acid
Ammonia and ammonia hydroxide
Concentrated nitric acid
Alum and aluminum sulphate
Organic amines
Neutral inorganic salts
Most refrigerants
Mineral oils and liquid fuels
Dyes
Beer
Cane sugar liquors
Glucose
Lacquers
Dark rosin
Fatty acids
Citric acid
Ammonium Carbonates

Sulphur
Hydrogen sulphide
Hydrogen peroxide
Carbon dioxide
Hydrocyanic acid
Organic acids (except those containing chlorine and formic or oxalic acid)
Alcohols
Organic solvents
Edible fats and oils
Phenols
Acetate solvents
Benzene
Coke oven gas
Oxygen and hydrogen
Milk
Propane gas
Carbonic acid
Gelatine

A cautionary note is necessary following a listing such as this, for in certain applications where temperatures, pressures, or presence of impurities are not normal, other metals may be more suitable. It is always wise when investigating the use of aluminum to obtain the advice of the aluminum producing companies as to the suitability of the metal for the intended service.

Aluminum possesses outstanding properties which warrant its careful consideration by chemical engineers. Primarily this is because of its ability to remain passive in the presence of many solutions, where a large number of other metals and alloys tend to catalyze or alter the chemistry of these solutions without themselves entering into the reactions. The importance of this when endeavoring to control chemical reactions is obvious.

The second point favoring aluminum for use in chemical work is that its corrosion products are colorless. There is a tendency for some solutions to cause slight corrosion, the result of which helps to immunize the aluminum against further attack. In many applications, maintenance of color is of paramount importance and aluminum is gaining more attention as a material of construction because its corrosion products generally do not cause discoloration.

With these factors in mind, it is apparent why aluminum and its alloys have rendered exceptional service in establishments manufacturing organic and inorganic acids, rubber, textiles, explosives, paint, varnish, and naval stores.

Food Plants: Aluminum is being used in the food industry quite extensively because of its ability to resist the corrosive action of most food products; among them, acetic and concentrated nitric acids, edible oils, milk and milk products, beer, and fruit juices. Here again, its passivity and the protection it affords against color contamination are of prime importance.

It has recently been brought to the author's attention that aluminum piping is being specified in a plant designed for the deodorization and purification of edible oils and vegetable shortening. In this case, the ability of aluminum to remain passive aids in preventing oxidation of the oils, which would result in rancidity. This, coupled with its resistance to corrosion by the oils and refining agents, makes it the most suitable metal for the application. The operating temperature will be 450 to 460 F, with pressures ranging from full vacuum to 60 psig. Standard IPS tubing and welding fittings ranging in size from ¾ to 2½ in. will be used along with type 316 stainless steel valves, aluminum Van Stone nipples, and carbon steel Van Stone flanges.

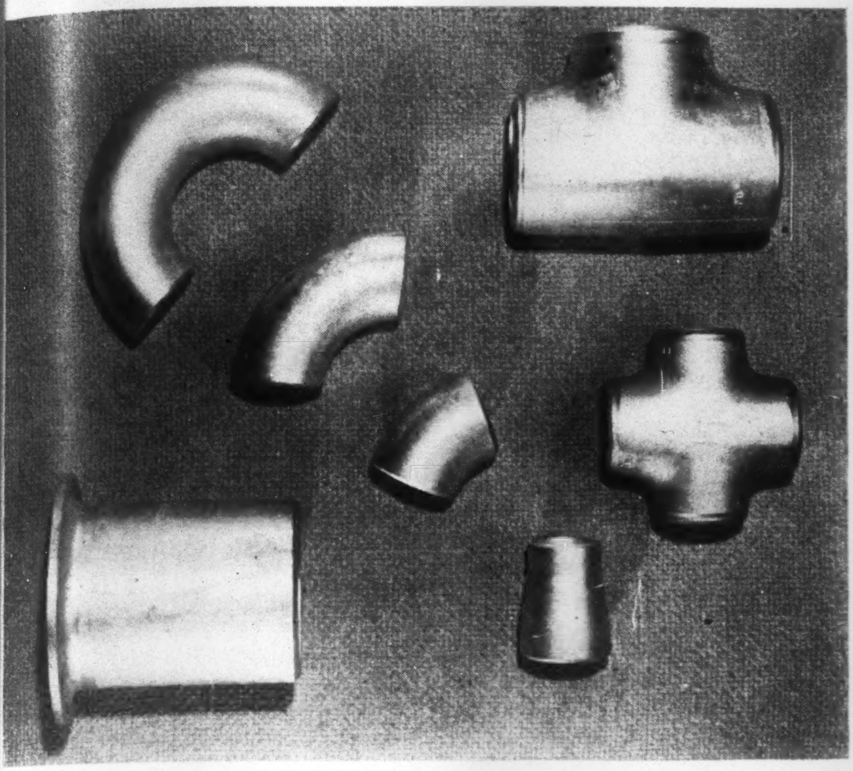
Soap and Cosmetic Plants: Because aluminum alloys guard against color contamination and aid in maintaining quality standards in the handling of fatty acids, they receive serious consideration by manufacturers of soap and cosmetics. They are also found useful in the construction of equipment for the vacuum distillation of these acids, where the separation of the acid from the mixed solution is accomplished by heat transfer.

Petroleum Refineries: In the petroleum industry, both in the production field and refinery, resistance of aluminum to the corrosive attack by hydrogen sulphide and sour crude oils, mineral oils and liquid fuels warrants its careful consideration as a material of construction. Internal aluminum components (such as bubble trays and caps) of many oil refinery vessels have been giving satisfactory results for some time.

Considerable interest is being shown in the use of aluminum piping for oil and gas transmission. Many test lines are being installed to check varying service conditions and under pressures up to 1000 psi.

Wrought aluminum grooved fit-

Aluminum welding fittings in standard weight IPS permit pressures up to 600 psi (depending on the size of the fitting and the temperature of the material being conveyed). Pressures up to 830 psi are often permissible when extra strong IPS fittings are used



Welding fittings of wrought aluminum and aluminum alloys are available in many types and in standard and extra heavy weights

tings in the heat-treatable alloys are also available. These fittings are designed to be used with the mechanical couplings offered for this service.

With both the pipe and fitting fabricated from the same high strength material, the piping engineer can take fuller advantage of the increased mechanical properties offered by the heat-treatable aluminum alloys.

Low Temperature: The aluminum alloys are now being recommended for service down to —300 F, because of their excellent mechanical properties at low temperatures. In the synthesis of gasoline from natural gas, as in many other operations in the various chemical fields, large quantities of liquid oxygen must be employed. Because the temperature involved is —300 F, aluminum is the metal used in the fabrication of pressure vessels, heat exchangers, and piping for handling this liquid. It might be mentioned here that chemical engineers foresee a growing number of uses for liquid oxygen in many chemical processes.

Irrigation: The light weight of aluminum has led to its wide use in irrigation piping in the south, southwest and northwest. Since this piping has a combination of mechanical and welded joints, it is readily portable and can be moved from location to location with a minimum amount of labor required.

Design Precautions Must Be Taken

Experience as well as field and laboratory tests have shown that the following precautions must be observed in designing aluminum piping systems.

Galvanic Corrosion: When aluminum is used with dissimilar metals in an electrolyte, it will respond as do other alloys; that is, the one higher in electric potential will tend to dissolve. Aluminum is higher in the galvanic series than most common metals. For this reason, the use of valves and other components of carbon steel, lead, tin, brass, nickel, monel, inconel, and copper with the aluminum alloys should be avoided, lest galvanic corrosion of the aluminum member occur. Insulating these materials will minimize this phenomenon. When it becomes necessary to use other metals with aluminum, *zinc or cadmium* plated steels and the *stainless steels* should be considered. These points should be kept in mind when choosing valves, companion flanges and bolting materials.

Flexibility: The thermal coefficient of expansion of aluminum is approximately twice that of steel. Because the yield strength of aluminum and most of its alloys is materially lower than that of carbon steel, its high coefficient of expansion requires that adequate provision for expansion and contraction must be made. A compensating factor is that its modulus of linear elasticity is only 1/3 that of steel.

Pipe Anchors, Hangers, and Supports: Whenever possible and for the reasons of galvanic corrosion given, anchors, hangers, and supports should be made of aluminum. If steel or cast iron is employed for these members, the surfaces contacting the aluminum should be galvanized or cadmium plated.

Insulation: Dry thermal insulation is satisfactory. However, if the piping is moist or collects condensate, boro-silicate glass fiber should be employed. Painting of the aluminum piping is also recommended.

Gaskets: Those materials which do not readily absorb moisture are best for use with the aluminum alloys. Synthetic resins, synthetic rubbers, cloth or paper impregnated with bituminous products, or rubber base compounds are most suitable.

NEW DETERMINATION OF RADIATION CONSTANT

A new experimental determination of the constant C_2 in Planck's and Wien's radiation laws has recently been made by M. S. Van Dusen and A. I. Dahl of the National Bureau of Standards, Washington, D. C. The value obtained, 1.438 cm-deg, is somewhat higher than that now used (1.432 cm-deg) in the International Temperature Scale and agrees very closely with the most recent values calculated from the atomic constants.

This result thus adds to the evidence that the most probable value of the constant is 1.438 and that the accepted value should be raised. The assignment of a higher value to C_2, on the basis of such evidence, is one of the more important of the changes proposed by the bureau in a revised draft of the International Temperature Scale which will be presented to the International Conference of Weights and Measures this year.

Design Engineer Reports on Operating Experience

PRACTICAL PIPING PROBLEMS

When we arrived at Panama, it had been expected that we would stay at Balboa long enough to permit major repairs, in order to clean up some of the more important items which had been accumulating for a long time. But after three days in port, during which a few minor repairs were made, we got orders to depart for Aruba to take on a cargo of oil, and thence to Providence, R.I.

We took on water, food stores, and just enough fuel oil to make the trip to Aruba and, on the fourth day, headed into the Canal. As on the previous passage through the Isthmus, it was necessary for a wiper to be posted on the casing top so that the cowl ventilators could be kept trimmed into the wind, insofar as possible; otherwise we would have suffocated in the machinery spaces.

We left the Canal in a very light condition and ran into a severe squall. As when we left Sydney, we were again forced to slow down and finally stop while we took on sufficient ballast to steady the ship. It was pitching violently and really giving the machinery a rough time of it. What finally caused the captain to call a halt to take on ballast was that we nearly lost overboard about six men of the deck crew. They were up forward on the forecastle deck stowing equipment when the ship tried to "go through one" instead of over it, and buried her bow in a good sized wave.

We arrived off Aruba two days later, in the evening, and waited for our turn to get into a loading dock. Aruba is quite a small island with a breakwater made by blowing two holes in the reef on one side of the island, this serving as the harbor. The operation of the harbor reminds one of the children's toy where you pound a peg in at one end of a tube and another peg pops out at the other. It was one-way traffic here, also; the ships entered at the west entrance and left at the east, each ship ordinarily awaiting its turn. In our case we seldom did things in a conventional manner. The fuel oil we needed for the trip had been miscalculated, and by the late afternoon of the next day they had to give us a berth to avoid the necessity of towing us in. We were burning the dregs, and were almost down to burning the chef's shortening.

We didn't stay long at Aruba. We were out of there in less than 24 hr, a record for us. We'd never been in a port less than three days up until this time, since leaving Baltimore. But Aruba is a very busy port operated by Standard Oil of New Jersey and, with typical American efficiency, they got us out of there in spite of us. We headed north through Mona Pass and on to Providence, managing to complete the trip with a minimum of trouble.

The discharge stop valve on the aft feed pump (a 3 in., series 60, cast steel, flanged globe valve) developed porosity, and a fine mist of feedwater was sprayed over the pump from a small pinhole leak on the bottom of the valve near the flange fillet.

The copper bypass line (about 10 in. size, as I remember it) around the main condenser on the circulating water system developed a leak. This was a hand-formed pipe made with a brazed, lapped joint. The leak appeared to be along this seam. In the forward pump room, the fuel oil transfer pump wouldn't operate properly. An inspection of the valve chests revealed that the bolts on the valves had come loose and that five of the eight valves were scattered around the valve chests. Only three of the valve springs were found. The pump was put in working order by installing spare valve assemblies, and operated properly thereafter.

Salinity Indicates a Leak Somewhere

We had one source of trouble that was causing us increasing concern. That was a sudden rise in the salinity of the boiler water. The condensate was checked and found to be normal, so the fresh water tanks were checked for contamination. One of our initial tests seemed to indicate that the tanks were in good condition but later checks showed about 80 grains (per gal) of chlorine in our starboard forward tank, so it became evident that there must have been a leak and that sea water was entering the tank.

However, this didn't seem—to me, at least—to be sufficient cause for the high boiler salinity, because all make-up water from this contaminated tank was evaporated before going into the feed system via the 10 psi back pressure steam line and the deaerating heater, but it must have been the case. The ease with which salinity could build up in the boiler was quite surprising. At least part of the reason for the salinity in the evaporated vapor was that I, as evaporator custodian, was probably carrying the water level too high, thereby causing "carryover." Also, the float feed valve on the evaporator often stuck, and either over filled the evaporator on some occasions, or forced us to operate on hand feed with (frequently) the same result. When low salinity fresh water had been fed to the evaporator, this hadn't made any difference.

In order to reduce the salinity, the boilers were put on continuous blowdown to the evaporator until we had reduced it from about 12 grains to approximately 5 grains. For awhile, we took our make-up from our aft freshwater tanks which carried distilled water. By re-evaporating this, we were sure of good make-up water. However, it was necessary later to use water from the contaminated tank, and we had considerable trouble trying to keep the boiler salinity down for most of the trip to Providence.

We had considerable trouble with our fresh water for the last part of our trip not only because of salt water leakage into one tank, but because the same tank was also heavily contaminated with oil, and all of our tanks were loaded with rust. The latter was so serious that the water coming from the faucets was reddish in color, and it was difficult to wash properly because of the heavy precipitate that formed.

The oil contamination was coming from the gland leakoffs of the feed pump and the feed pump turbine. The drains from these glands had been piped to our forward starboard tank in an effort to conserve this water, which usually was in a considerable amount. As a wartime measure, this had been connected up by the crew which had preceded us. A condenser and cooler made out of 2 in. pipe with an inner ¾ in. pipe was provided so that the drains would not flash in the tank.

Whether or not the tank had accumulated any oil during the tenure of the previous crew is not known. We didn't notice any until well along on our voyage. It was discovered on the sounding rod when sounding the tanks for the water level. With the oiling methods prevailing on our ship, and the extravagant use of oil on the feed pump and feed pump turbine bearings, it is quite possible that the oil accumulated at a highly accelerated rate. By the time we returned to the United States, there was quite a heavy layer of oil on the surface of the water in the tank. Being on the surface, it didn't seem to give us much trouble. It was a hazard, though.

Rust Problem Caused by Transfer of Water

The rust problem seemed to have been caused primarily by the frequent transfer of water from tank to tank in order to keep up with our requirements. This wasn't really necessary, but it was the way *we* operated.

These tankers had been originally designed for the Texas and coastal, and the Caribbean trade — short haul service. During the war they were used for worldwide service without any changes in the stores spaces, and fresh water became one of the vital items to be provided for. With the single evaporator on these ships, and careful operation and servicing, it was possible to take care of the entire fresh water requirements on the ship. The ship's tanks had a normal capacity of 292 tons, which would provide the full requirements for crew usage and boiler make-up for at least 15 days. Our daily requirements were about 18 tons. The capacity of the one evaporator was 20 tons per day with salt water, or 40 tons per day when evaporating fresh water to make distilled reserve feedwater, for boiler make-up. The above capacities were based on a tube fouling factor of 20 percent.

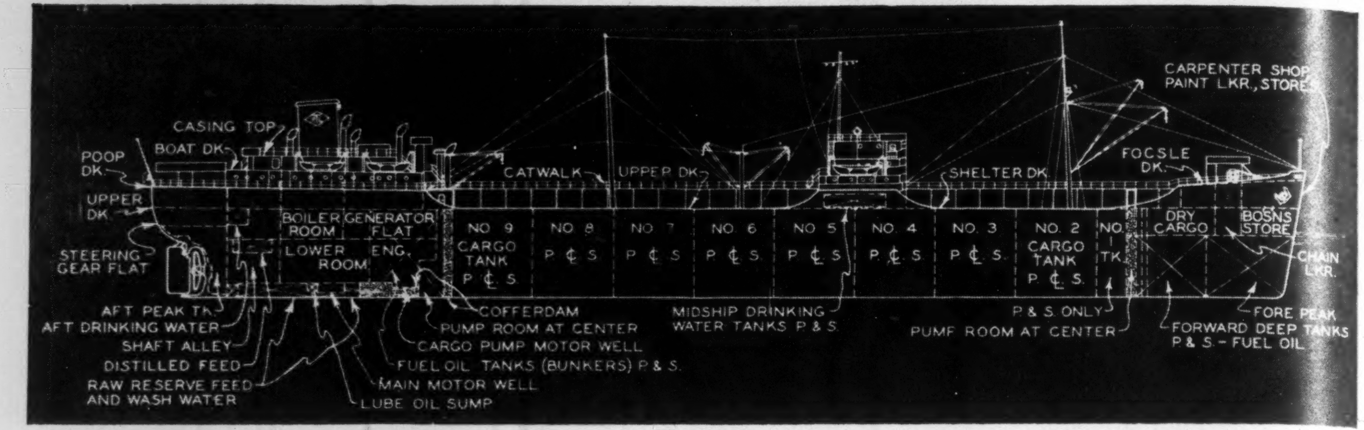
JOHN H. CLARKE sought information on the problems with piping systems, pumps, valves, heaters, control, and other mechanical equipment faced by the operating man . . . how designs perform in actual service . . . how equipment is actually operated . . . when he (a marine design engineer by training and profession) shipped on a tanker as junior third assistant engineer. By the time his seagoing was completed (he's back on land as a design engineer with the Standard Oil Company of Indiana) he got plenty of practical information on piping, pumping, heating, ventilating, and other subjects. His comments and observations are continued here from our February issue. Much of what he found out applies not only to marine work but to the design, operation, and maintenance of equipment in plants and buildings.

It was interesting to learn that the previous crew had requisitioned a spare set of evaporator coils, and by frequent changing of the coils and by keeping the unit properly blown down and clean, they were able to keep up not only with their fresh water and boiler make-up requirements, but were actually able to make more water than they used.

On later ships of this design, the problem was made easier by providing two evaporators, one for sea water and one for fresh water for boiler make-up. Both evaporators were the same capacities as the original evaporator. Prior to the addition of the second evaporator, various tricks were resorted to in order to expand the storage capacity or to recover available water. Collecting gland leakage, as previously mentioned, was a favorite but it had the drawback of oil contamination. Another frequently used method was to pipe the deck drains from the higher decks aft to the fresh water (double bottom) tanks. In reasonably calm weather, it was possible to do this with a minimum of contamination; in rough weather, the drains were plugged. One chief engineer claimed to have picked up 30 tons of fresh water in this manner in one tropical rain storm.

Our ship had at one time been piped to pick up rain water but this system was disconnected prior to our getting on the ship, so our crew resorted to another method of providing fresh water—that of creating more storage space by using the various cofferdams and the forepeak.

The principal disadvantage of this method was that for every ton


CASING TOP
BOAT DK.
POOP DK.
UPPER DK.
STEERING GEAR FLAT
BOILER ROOM
GENERATOR FLAT
LOWER ENG. ROOM
CATWALK
UPPER DK.
NO 9 CARGO TANK P ℄ S
NO 8 P ℄ S
NO 7 P ℄ S
NO. 6 P ℄ S.
NO 5 P ℄ S
NO. 4 P ℄ S
NO. 3 P ℄ S.
NO. 2 CARGO TANK P ℄ S.
NO. 1 TK.
SHELTER DK.
FOCSLE DK.
CARPENTER SHOP PAINT LKR., STORES
DRY CARGO
BOSNS STORE
CHAIN LKR.
AFT PEAK TK.
AFT DRINKING WATER
SHAFT ALLEY
DISTILLED FEED
RAW RESERVE FEED AND WASH WATER
COFFERDAM
PUMP ROOM AT CENTER
CARGO PUMP MOTOR WELL
FUEL OIL TANKS (BUNKERS) P & S.
MAIN MOTOR WELL
LUBE OIL SUMP
MIDSHIP DRINKING WATER TANKS P & S.
P. & S. ONLY
PUMF ROOM AT CENTER
FORE PEAK
FORWARD DEEP TANKS P & S. – FUEL OIL

Outboard profile showing the location of the various tanks, the capacities of which are indicated in Table 1. The lubricating oil settling, storage and gravity tanks (not indicated) were in the engine room fidley about boat deck level, just forward of the stacks. The cofferdams which were used for fresh water are shown by shading. "P." means port, and "S." means starboard.

of fresh water carried, we could *not* carry a ton of cargo oil. Had we confined ourselves to the normal storage capacity, this would have meant that we could have carried nearly 600 tons more of cargo—in excess of 160,000 gal of oil. On our ship (see accompanying profile) the forepeak, the cofferdams at the forward and aft pump rooms, and the cofferdam in the double bottom tanks (which isolated the fresh water tanks from the fuel bunkers and the pump room) were all filled with fresh water. Even the way *we* operated, the capacity of none of these tanks was needed, excepting part of the capacity of the forepeak. Even this could have been easily eliminated had we operated our evaporator on salt water part of the time. This the chief refused to permit.

In order to get the water from the various tanks to our fresh water tanks it was necessary to use the fire and ballast pump in the forward pump room, and to pump the water in the forward cofferdam and forepeak through the fire main aft to a fire hose connection, and thus through a hose to the tank filling lines. There was no way the cofferdam at the aft pump room could be pumped out (except overboard via the steam cargo stripping pump) so a gravity line was connected from the existing cofferdam suction lines (to the stripper pump) to the double bottom fresh water tanks. This connection was a waste of materials and money, and was contrary to the Coast Guard and U. S. Public Health Service regulations.

But the storage of water in the *double bottom* cofferdam was the most foolish. It could only be removed by the bilge pump and there was no way to recover the pump discharge even if anyone had wanted to. We carried this water for most of the trip. The only reason we didn't carry it for the entire trip was that an oiler inadvertently opened the wrong valve one time and pumped out part of the water in lieu of pumping the bilge.

From the above it is readily apparent that every time we pumped fresh water from the forward tanks, or drained the aft cofferdam by gravity, we were simply loading up our normal fresh water tanks with rust. Actually, it accumulated primarily in the two forward double bottom tanks, and to some extent in the aft peak tank because these were the tanks to which the water was transferred. The aft double bottom tanks were kept filled with double distilled water for emergency make-up to the boiler. Incidentally, the aft peak tank, on these ships, was normally a fresh water tank.

Our arrival at Newport and Providence was somewhat of a letdown. The captain had expected to accomplish another one of his "on the dot" appointments with the pilot boat, but he reckoned without the local weather man. When we got in the vicinity of the harbor, a deep fog settled down and we spent most of the night barely under way. This was a typical pea soup fog, and at times we couldn't even see the bow of the ship. Not being equipped with radar, we had to be content to feel our way in. We finally located Block Island below Newport, and shortly after this the fog lifted sufficiently to give us a view of the shore but the pilot was nowhere to be seen. After hours of waiting and much frantic sputtering via radio, we finally connected with the pilot boat and they arrived at our ship late in the afternoon.

Change-Over Hard On Maintenance, Operation

By the time we got to Providence proper, it was late in the evening and dark. It took two days to unload our cargo as it was unloaded at two docks. With the unloading operation completed, the crew was free to leave the ship as soon as relieved, and after being paid off, of course. This crew really left, too. When the smoke cleared away, only the captain, the purser, the electrician, the first engineer, and I were left of the crew that arrived in port with the ship. It is this kind of frequent change-over that is so hard on the maintenance and operation of these ships.

There were many rumors as to where the ship would head for next, but the most reliable seemed to be that she would go to New York City for repairs and then would make a trip to the Caribbean—after which she would be laid up. It was on this basis that the new crew was taken on. I planned to leave at Providence, but decided instead to stay on until we got to New York City. The new chief engineer was anxious to have anyone stay who would, because he wanted experienced men on the ship. Our new engineering crew was not too experienced with this type of ship, particularly the oilers and firemen. But the engineering officers who came on were a fine bunch even if they didn't all have tanker experience. We were particularly impressed with the new chief engineer. He was an "old hand" with these tankers but in age was in his late 20's. What he didn't have in age, and possibly experience, he made up in thoroughness. And he certainly knew his engine room and how he wanted to operate it.

One of his first acts on taking over was to ask when the main turbine overspeed trip had last been tested. The answer was that *it hadn't been tested.* So he proceeded to check it. As previously mentioned, at least five of these turbines had run away on other ships and the overspeed trips were supposed to be checked at each port to be sure that they were in proper working order. Following this, he took the first engineer through the engine room and told him how he wanted to operate the plant.

Traps in Drains from Turbine Extraction Valves Bypassed

When we left Providence and all through that — and subsequent — maneuvering, the turbine extraction drain valves were all opened. He didn't just open them to the traps. He bypassed the traps. As he put it, "Why take a chance?" For the first time, also, we used extraction steam from the turbine; the old chief didn't believe in it. We didn't use any 10 psi extraction steam because the requirements were low, but by using the 70 psi extraction steam we reduced the feed and oil heating loads on the desuperheated steam reducing valves considerably. They had been used beyond their design capacity up until that time.

At first we operated our evaporator on 10 psi steam with the vapor discharging to the drain cooler (first stage heater) at 8 psi absolute. But we seemed to be having some trouble with carryover, and in addition we needed all the water we could get. So we changed over so that the steam to the coils came from the 70 psi line and the vapor discharged to the 10 psi system. The first method would ordinarily be preferred for operating the evaporator, providing the carryover could be kept down to a reasonable amount. Here again, our trouble was probably due in part to carrying too high a level in the evaporator.

The reason that we were short of water was that after leaving Providence, it was necessary to clean our cargo tanks before we arrived at New York. Because of this it took us 2½ days of circling to get there. Our tank cleaning (Butterworth) machines were completely worn out and were beyond repair. So the crew was going to clean the tanks with hot sea water by hand. Prior to this however, they steamed out the tanks by turning on the fire steam snuffing system. This procedure had to be brought to a halt when we got very low on fresh water. All of the tank cleaning *steam* was, of course, a complete loss as far as fresh water was concerned.

Even after we shifted the evaporator to operation on higher pressure steam, we still couldn't keep up with the tank steam cleaning losses. For such a short trip there was no point in shifting to salt water evaporation and back to fresh water. Also, we had now learned that when the ship reached New York, it was to be stripped and towed to the James River to be laid up. So we made out as best we could with the water we had on board.

The chief was the only one of the three engineering officers who came on at Providence who was experienced with turbo-electric tankers. The other two new engineers particularly wanted turbo-electric experience and that was why they took the jobs. They were all fine and cooperative fellows, and the electrician and I certainly wished that they had been on the ship the previous six months; it never would have been the same ship. This crew all worked *together*.

Because of the inexperience of the two new men, the actual duties were somewhat mixed up. The first assistant was still the same man who had joined the ship at Sydney. I was made second assistant, mainly to have someone on the early morning watch who was familiar with the machinery. The third assistant held a second engineer's license, and the junior third engineer held a first assistant's license, but we didn't let any of this bother us. I needed plenty of help from them in taking care of the boilers, particularly with the salinity trouble we were still having because of the shortage of fresh water, and because the one tank was contaminated with salt water. In turn, I helped them to become familiar with the machinery, piping, and particularly the electrical propulsion controls.

Operating these controls is somewhat like running a car. First you have to shift gears; thus, (1) closes the contacts for the proper direction of rotation, (2) brings the propulsion motor up to speed as a squirrel cage motor, and (3) shifts the motor over to synchronous operation with the main generator. After this, you "step on the accelerator" by pulling open the throttle lever which resets the governing mechanism to a higher speed, as desired. But most of the operation of this or any other power plant is in knowing what the equipment is, how it operates, where the critical valves are located and, most of all, what equipment has to be watched and pampered. Once you learn this, it can be a lot of fun if you don't take it too seriously. Me —I'm a natural born "worry wart" and find it hard to relax as long as things aren't going just as they should be. And on a ship they never are. You never know when something is going to go wrong.

About the first day out of Providence we had a bit of trouble with the soot blower system. We could blow tubes with steam from either boiler, and in this case we used the port boiler. After blowing the tubes, the system was again secured except that when we tried to close the 2 in. cutout valve at the superheater header it wouldn't close. This left the full boiler pressure on the soot blower mains for the remainder of the trip. Apparently the stem bushing threads had worn out and would no longer hold to close the valve against pressure. Probably this sort of thing has happened many times before, but it was a new experience for me.

Approaching the New York harbor pilot station with everything apparently in good running order, we ran into more trouble. In accordance with the practice of many chief engineers, our chief requested that the second auxiliary generator be warmed up and synchronized with the one in operation so that it could be used for excitation or ship auxiliary power in emergency. Of course, the latter was divided between the two auxiliary generators. We had both the auxiliary

Table 1—Tank capacities for the ship described in this article. All tonnages given are in *long* tons

Oil

Cargo oil—		
Maximum	140,000 bbl	5,964,000 gal
Normal*	90,000 bbl	3,780,000 gal
Fuel oil	9,698 bbl	407,300 gal
Lubricating oil—		
Sump		1071 gal
Gravity		1000 gal (total of two tanks)
Storage		500 gal
Settling (used for storage or for oil to be purified)		1200 gal

Fresh Water

Drinking—99.8 tons, 26,900 gal (total of three tanks)	
Raw reserve feed & wash water (including after peak) normal	292 tons
Capacity** of forepeak and cofferdams used for fresh water	582 tons
Total	874 tons
Distilled (double distilled) reserve feed	36.4 tons

*The maximum capacity would be with *all* tanks *full*. For the maximum permissible draft, we could carry only about 90,000 bbl. Without the wartime superstructure which was on the ship, this would have been somewhat higher.

**These tanks should never be filled with fresh water normally, and only the forepeak was arranged to carry even ballast.

and the main turbines exhausting to the main condenser, which would not be desirable for port operation particularly on a ship with leaky glands on the exhaust valves. The chief hadn't learned of this last point, and up to this time no one had thought to tell him.

Vacuum on Condensers Lost

However, in bringing in the second generator, it was intended to shift the exhaust of both auxiliary turbines over to the auxiliary condenser. In so doing, we lost our complete vacuum on both condensers. The first engineer believes it started when he made the mistake of opening the air valve on the ejector ahead of the steam valve. This may have started the trouble, but the mistake was almost immediately corrected. Our vacuum didn't come back even though we stopped the main turbine and recirculated cool water through the ejectors.

Ultimately, we had to shut down the second auxiliary turbo-generator and close its exhaust valve. We were then able to regain our vacuum, and to get under way, with the one auxiliary turbo-generator exhausting to the auxiliary condenser. The above seemed to indicate an air leak in the second auxiliary turbine exhaust—probably in the exhaust valve gland that had given us similar trouble before. But when we later brought in and paralleled the second auxiliary turbo-generator we had no trouble in maintaining our vacuum. Whatever it was that caused the trouble the first time had evidently sealed itself since then.

Table 2—Fresh water requirements for this ship†

	Tons per day	Gal per day per man
Drinking water	1.66	10
Wash water	3.37	20
Make-up feed	12.23	
Total	17.26	30

†These figures represent the averages for several trips, each of about three weeks duration, under semi-tropical conditions, and including pump gland leakage. Our leakage was about normal for the sizes of pumps used. The capacities were taken from the actual tank soundings and the ship capacity tables. The drinking water usage includes the water used for cooking, preparing foods and vegetables, and for dishwashing. All water used in the galley for any purpose is required to be potable. The washing down of the deck in the galley on our ship, however, was done with salt water, so this usage would not be included in the above. These figures are about average for this size and type of ship.

While all of this vacuum trouble was going on in the engine room, the ship slowed to a stop. According to the captain we couldn't have done a better job of maneuvering to the pilot boat if the stop had been intentional. By the time the pilot was aboard and ready to get under way, we were ready to go in the engine room. We then proceeded into the harbor and anchored off Staten Island where we stayed until the ship was ready to be towed out of the harbor.

How Not to Light a Burner

My last duty on board this ship was another long night watch. And it was definitely an *all night* watch, too. We were short handed, because it was nearly impossible to induce any good crew members on board for just a few days. The fireman on duty was evidently an old hand at firing. But he must have imbibed too freely before coming on watch, because it became increasingly apparent that he was in no condition to tend the boilers. Even though only one boiler was in operation, and only one burner was being used in that, we had to watch him like hawks to keep him out of trouble.

He changed to a clean burner once, and instead of putting in a clean burner and lighting it and then removing the dirty burner, he just took out the dirty burner, put in a clean one in its place, and lit it off the brickwork. This, of course, is one of the better known methods of promoting a "flare back" or fire-box explosion. The oiler saw him just too late to stop him on this one. Later he tried it again, but this time we saw him in time and saw to it that the burners were changed properly.

His attempt to operate the soot blowers was even more ludicrous and since it was no longer safe to have him in the fire room, he was sent off watch for the rest of the night. The oiler and I felt much safer finishing up with the soot blowing and checking the boiler and the engine room equipment ourselves. Such was my last day on board *that* ship.

[A final "summary article" will conclude this series by Mr. Clarke.—Ed.]

EARNINGS AND SALES "HIGHEST IN HISTORY"

Carrier Corp., a leading manufacturer of air conditioning, refrigeration and industrial heating equipment, has reported a net profit of $2,272,774 or $3.44 per common share for the fiscal year 1947, as compared with $309,439 or $0.20 for the preceding year.

These earnings were after certain extraordinary charges, including $789,274 of expense incident to the acquisition and partial utilization in 1947 of a sizable new plant just outside the city of Syracuse.

The corporation completed sales of $52,910,590 during the fiscal period ended October 31, 1947, as compared with $23,476,247 in fiscal 1946. This increase reflected both the heavy demand for products and services and the greatly improved production facilities.

Both the earnings and the sales figures reported by the corporation were the highest in its history.

New business booked during the fiscal year totalled $47,686,249. The comparable figure for the preceding 12 months was $40,053,004.

The backlog of unfilled orders totalled $21,668,140 as of October 31, 1947, a decrease of $9,967,051 from the same date a year earlier. More than half of this decrease resulted from cancellations by the corporation of orders booked prior to fiscal 1947. This action was taken in order to establish a thoroughly realistic basis for current production planning.

Air Conditioning Equipment for New Weaving Mill Installed on Platforms

THE F. DUCHARNE Silk Co.'s new "controlled conditions" weaving mill at Glen Rock, N. J., represents the first use of the Austin Co.'s system for standardization of industrial air conditioning.

The plant proper has two unobstructed 80 ft bays with 17 ft clearance, and has welded H section trusses, which have permitted maximum flexibility in the installation of materials handling systems and general building equipment. The complete absence of fixed partitions in the plant proper has not only simplified the overall layout of receiving and shipping departments, stockrooms, twisting and sizing, shearing and picking, winding, quilling and warping departments in one bay paralleling the large weaving area, but leaves the plant adaptable for any future changes which may prove desirable.

All collateral functions, including employee lunchroom, locker rooms and toilets, machine shop and machine stock room, boiler room, plus technical and office activities, are housed in a 30 ft span section which forms a right angle flanking the manufacturing area on two sides.

Air conditioning equipment for the factory area is concentrated on two platforms, which are connected by a common catwalk extending the full width of the plant. The entire weight of platforms, air conditioning and ventilating equipment, related service facilities, and ductwork is carried on the bottom chord of the H trusses.

Three units, each consisting of a fan and capillary air washers with capacities of 16,500 cfm, serve the factory, where deep well water obtained at 55 F is used for cooling. Steam from a small oil fired boiler is circulated through the fan units for winter heating. The trusses, however, have been designed to support additional power panels and refrigerating compressors in the event that these are ever required to handle increased loads in the plant. The air conditioning system will provide five changes of air per hour and will maintain accurate control of temperature and humidity.

The office area will be served by separate air conditioning equipment located in the 30 x 40 ft second floor area above the entrance, where the pattern storage vault is also situated.

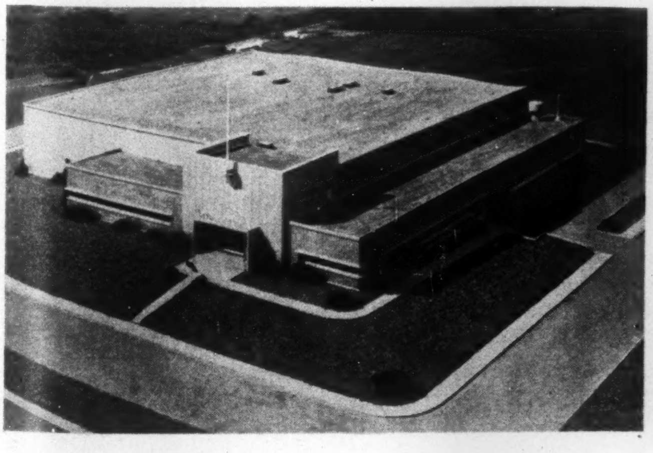
The simple but impressive entrance is located in this two story section which is completely faced with limestone, in contrast with vertical panels of aluminum used throughout the office exterior, and face brick used throughout walls of the plant itself. A deep canopy of limestone provides weather protection at the entrance and supports the modern 2 ft block letters which identify the plant. A 2½ ft band of continuous sash in the office section carries out the horizontal lines which are introduced in the plant area by runs of glass block, interrupted at intervals by double glazed insulating vision panels.

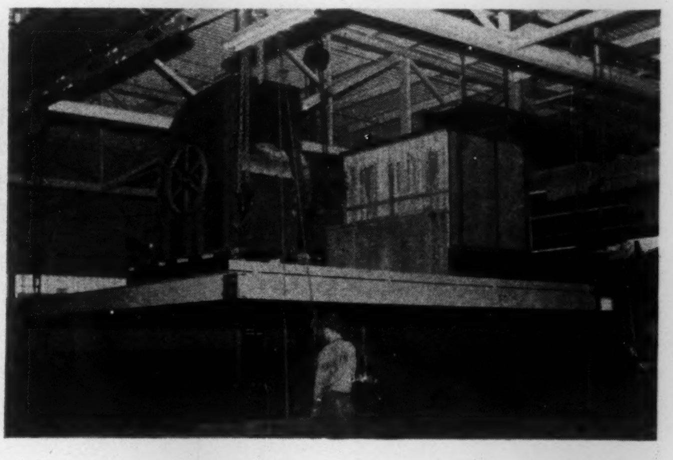
The entire plant has a metal roof deck with 2 in. fiber glass insulation, covered by built-up roofing and a maple floor. Continuous fluorescent troffer lighting suspended over the aisles provides in excess of 50 foot-candles intensity. Power for the warping, winding and weaving equipment is carried in underfloor duct with provision for outlets every 2 ft.

The offices have acoustical plaster ceilings with recessed fluorescent lighting fixtures and asphalt tile floors.

Left: Deep well water at 55 F is used for cooling the plant and office sections. This "aerial" view is a picture of a model of the structure. Right: Fans and capillary air washers being used in the air conditioning system at the new weaving mill were installed on the air conditioning platforms at floor level. This idea, which is the basis of the "unit area system" for installation of equipment in controlled conditions plants, permitted a material reduction in the time required for installation of this equipment, which is supported on standard trusses.

[Photos courtesy the Austin Co., engineers and builders]





Fluid Flow and Heat Transfer in Artificially Roughened Pipes Studied

By V. L. STREETER

Director, Fundamental Fluids Research Laboratory

Illinois Institute of Technology

IN THE FLUIDS research laboratory of Armour Research Foundation, on the campus of Illinois Institute of Technology, Chicago, a fundamental research project is underway which is expected to clarify and increase existing knowledge of turbulence in fluid flow and heat transfer. Systematic measurements are being made of velocity distribution, pressure drops, heat transfer, temperatures, and roughness characteristics of the boundaries, for a wide range of Reynolds numbers, pipe sizes, and types of accurately reproducible roughness. The basic data should soon be available for friction factor and heat transfer coefficients in terms of roughness characteristics.

The present project is being conducted to supply basic data for laboratory experimentation. The analytical phase of the project would be an evaluation of the experimental data, using established theories and methods now available, and devising new methods based on rational theory and the data at hand.

It is proposed to carry out fundamental studies of the nature of flow first, and to reserve studies of the effect of roughness on heat transfer until a later time.

How Rough Surface Is Obtained

As a result of many attempts at obtaining a satisfactory roughness surface, a design of a square thread was selected. Such a design was cut into the inner wall of 1 ft sections of aluminum pipe, which were normalized and broached to give uniform sizing and smooth interior finish. Threads were cut 0.055 in. square (nine threads per square inch), and the inner diameter, from land to land of pipe thread, was 4.547 in. The end of each section was threaded on the outside so it could be joined to and disassembled from adjoining sections.

The circulating water system set up for the project consists of a large water tank, open to the atmosphere, with an outlet leading to the suction of a centrifugal pump. The pump delivers water into a surge tank in which air trapped above the water serves to damp out irregularities in pressure.

From this tank, the water flows through a straightener and a certain length of calming section into a test section 20 ft long.

Static pressure readings are taken by means of piezometer rings shrunk on the pipe at points located at 6 ft intervals along the test section. Openings into the piezometer rings are flush with the trough of the grooves and are located at four different positions around the pipe. They are connected to heavy rubber tubing which transmits the pressures to a micromanometer. With this instrument readings to 1/10 mm can be obtained.

At the outlet of the test section is located a specially designed device for traversing the cross section. Either a hypodermic needle impact tube or a static tube by which the sum of velocity or static head, or static head only, at different points of the cross-section, can be measured, respectively. The return line, leading through a venturi meter and valve, carries the water back to the open storage tank.

A preliminary determination of the friction factor shows surprisingly small value for this relative roughness — about 0.023 when the Reynolds number ranges from 3.3×10^5 to 8.8×10^5. This apparently is due to the relatively small spacing between the roughness projections. For this reason two other sets of pipe sections of the same size but with different spacings of roughness projections have been prepared and will be tested to determine the change of friction factor.

For the proper location of the piezometer openings, pre-investigations carried out in this laboratory prove that the pressure readings for openings in the bottom of grooves are fairly constant as compared with openings in the lands. The next object of the experimentation is to determine how the change in roughness and length of the calming section will affect the pressure gradient and velocity distribution in the test section.

New Water System Being Installed

With the use of the hypodermic needle installed in the traversing device, the velocity traverse obtained in the end of the test section gives a fairly reasonable pattern. Difficulties have been experienced, however, because of foreign materials which are always carried by the water and clog the needle from time to time. To keep the water clean a new circulating water system is being installed in the laboratory. Water leading to the new system will be filtered. It will have an increased capacity of 2500 gpm at a 200 ft head, and will provide a calibration bottle to permit the calibration of the venturi meter in place by the volumetric method. More detailed results and detailed velocity distribution studies will be obtained after its completion. By that time, with the results of the pre-investigations to clear up some of the uncertainties of experimental technique, the main tests of roughened sections can be accomplished with much more confidence in the results.

R. G. VANDERWEIL, until recently project engineer with the Chase Brass & Copper Co., has attempted in these articles to explain at least some of the reasons for the contradictory statements about radiant heating and to present information pointing to an understanding of the subject. In his article this month, he considers five specific radiant heating questions and comments briefly upon them

Practical Pointers on RADIANT HEATING DESIGN

Anyone attempting to design radiant heating systems with the aid of available literature will soon find himself bewildered by contradictory statements. That many engineers actually are confused has been brought out repeatedly in radiant heating forums and open discussions attended by the author. It seems worthwhile to point out some of the more important contradictory statements and to re-state the basic principles inherent in all proper methods of design.

In the July HPAC, we discussed panel heat output and attempted to reconcile some of the varied data on this subject. In September, attention was given to tube heat output and panel loss, tube or pipe spacing, and variations in panel heat loss. This month, we take up five other panel heating questions and comment briefly upon them.

Question 1—Ceiling or Floor Panel?

Unfortunately, we hear of many heated discussions and see too little cool thinking on this question of ceiling or floor panels. *In the author's opinion,* in rooms of 15 ft ceiling height and less, the ceiling panel has a considerable number of advantages over the floor panel. These primarily pertain to comfort and to operation of the system.

However, there is one advantage inherent in floor panels that counts heavily in cases where economic considerations are of prime importance; for well insulated structures they are less costly to install. In low cost housing, for instance, we may find that initial savings amounting to 10 percent or more will weigh more heavily than additional comfort. One point, though, we must remember—just because floor systems are less costly to install, we must not let our enthusiasm for economy run away with us to the extent of forgetting that ceiling installations are superior (in the author's opinion) in comfort although more costly in erection.

In spaces higher than 15 ft, the relative merits of floors increase and the difference in comfort conditions becomes less and less important. One point relating to floor panels must be noted once more: keep the panel output within allowable limits in order to avoid overheated feet and fatigue of legs.

Question 2—How Should We Size Boilers for Radiant Heating Systems?

Again we find contradictory data on sizing boilers for radiant jobs. According to British publications (which have been frequently reprinted in the United States) and also according to numerous statements of U. S. operators of radiant heating systems, the fuel consumption is lower than that of conventional systems. This would indicate boilers smaller than those selected to cover the heat losses computed according to the ASHVE's Heating, Ventilating, Air Conditioning Guide.

Then again, calculations suggested by Prof. F. W. Hutchinson would indicate that with relatively high outside temperatures (35 F) heat requirements are greater than those met with conventional systems. It may seem safe to take the "middle of the road" and select the boiler size according to the Guide's heat loss computations, although this statement cannot be backed by accurate test results.

Question 3—Panel Lag and Control

Due to the lag or heat storage principle, the radiant heating control problem is of considerable magnitude. Although this heat storage is relatively small with coils in hung ceilings, it becomes of greater importance with coils in concrete floors and is most critical in slabs laid directly on the ground where the earth itself presents a basin for heat storage.

Since none of the present control systems can predict the influx of heat due to the sun, some ceiling systems are known to overheat from 2 to 4 F as soon as the sun strikes the structure. Some floor systems are known to operate with a temperature increase of 3 to 10 F, depending upon panel structure and glass size. Great temperature increases may prove to be troublesome and are met in some of the types of the basementless homes where the floor continues to deliver heat for many hours even if the coil circulation is stopped entirely.

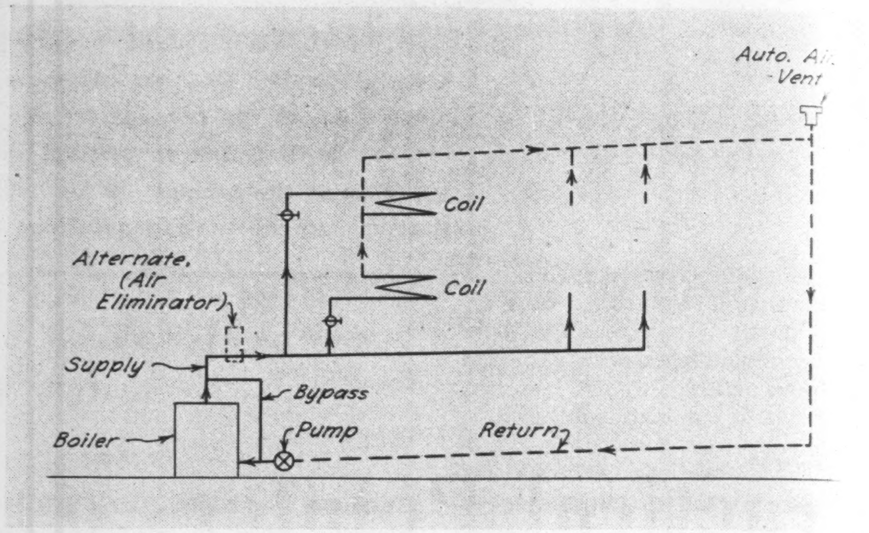
Complaints arising from heat storage can be minimized only by use of moderate floor temperatures and for this reason, many systems employ an outside thermostat to maintain the water temperature at the lowest feasible level at all times In addition to this, a room thermostat used as a "limit switch" may shut off the heat supply to the room as soon as room temperatures increase unduly.

Considerably less critical are the conditions with ceiling panels where much thinner masses have to be dealt with, the author believes. At present, little conclusive experience has been gained with the various types of control and considerable research work will have to be done before we shall be able to standardize on preferred control schemes. Mere analytical treatment of a subject as complicated as this must be based on simplifying assumptions which may or may not be correct and thus should be confirmed by numerous test installations.

Question 4—Basementless Structures

One of the major problems arising with basementless construction was previously mentioned; namely, the floor heat loss. This problem is important with both ceiling and floor installations.

If the slab is not properly insulated, the heat loss of the floor heating systems may almost equal the heat supply to the room, and with ceiling systems, the floors may be cold. However, with properly insulated slabs, the floor temperature of ceiling heated rooms is greater than the air temperature (re-radiation effect, equivalent to that resulting in hot sidewalk surfaces on sunny days) and floor panel losses may be reduced to below 25 percent. The importance of floor insulation is apparently not fully recognized. One installation has come to the author's attention where, due to such losses, the structure was not sufficiently heated and a large part of the heat was consumed in melting snow around the circumference of the building.



Two basic methods of venting are used. According to the first, the air collected in coils is allowed to rise from the coil outlet to the vent point as shown. According to the second, air is driven out of solution and discharged near the boiler (see "Alternate") and the circulating water can absorb new air as it cools in the coils

Question 5—Venting Radiant Heating Systems

Little general information is found in the literature on venting radiant heating systems. We know that radiant heating presents us with additional vent problems. Whereas in a conventional system the air entrapped in the radiator escapes through the riser to the attic supply header, air is frequently trapped in the radiant heating coil as the system is filled. This is due to the fact that the coils cannot be installed perfectly level and air remains trapped at high points. As the pump is started, this air is driven to the coil outlet and from there to the return riser which usually drops down to the main in the basement. Sometimes air refuses to flow downward (with low flow velocities in riser), and airbound coils result. The remedy is to run coil return risers up rather than down, connecting them to a common manifold in the attic which is vented at the high point and then connected to the pump suction in the basement.

According to another method, an air eliminator is installed at the connection between the boiler and the main which disposes of the air driven out of solution as the water is heated in the boiler. The water cools down in the system, dissolves further air, and again disposes of it at the boiler. This method will operate more efficiently if the system is designed for large temperature drops.

Engineer Must Use Judgment

Due to the amount of contradictory information on radiant heating contained in published literature, the engineer has to rely on his own judgment in selecting proper design data. When confronted with this difficult task, he should consider that thousands of installations have been installed according to each one of the major design methods and hundreds according to less known methods and that the overwhelming majority of these installations work. For this reason, it should not be too difficult to study the literature, select a more or less conservative method, and design the system.

If the author's articles prove helpful in selecting such methods as you wish to use in the future, they have served their purpose.

Good for Men and Machines

AIR CONDITIONING is out of its infancy, but it is still growing. Air conditioning both for comfort and for control of industrial processes is expected to grow, for the market is far short of saturation in either field.

Although the human body has a better temperature regulating mechanism than do many animals, it can still endure only a relatively narrow temperature range. The highest tolerable temperature for a clothed person in good health is only about 88 F in air saturated with water vapor, and about 138 F in dry air. But for maximum comfort and efficiency over extended periods, temperatures in the 70's, 60's, or even the 50's, depending on the humidity and the individual's physical activity, must prevail. Installation of an air conditioning system in an industrial plant increases worker efficiency and sometimes improves product quality. Because the air generally is filtered as well as cooled, reaction to allergies, such as hay fever, caused by airborne dusts and pollens, is sharply reduced during working hours. Whether colds and respiratory diseases in general are significantly reduced is, however, still a question. Large reductions in absenteeism and a general increase in output are reported.

Large Potentials in Many Buildings

A recent survey disclosed that there are more than 2200 air conditioned theaters in this country, but there are still 15,000 theaters without it. Over 1000 department stores are air conditioned, with installations that average more than 100 hp, but almost three-fourths of the country's department stores still lack this facility. Although about 6500 restaurants are already air conditioned, this is a leading field for further installations, even though the average unit is rather small. Another large potential market lies in hotels, few of which are as yet completely air conditioned, and in banks and hospitals, which have only recently begun to use air conditioning.

The growing popularity of the heat pump is expected to increase the number of home air conditioning units. The pump, a refrigerator-like mechanism which draws heat from outdoors for winter heating, may be reversed in summer to pump heat out of the house. The convenience of one automatic device for year 'round comfort makes it especially attractive for climates where the need for both heating and cooling is balanced.

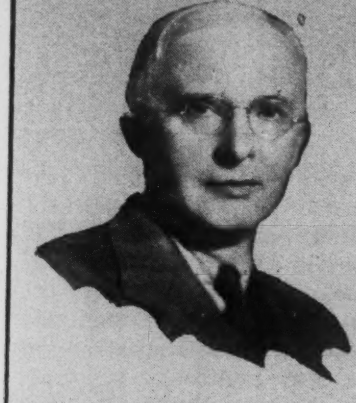
Production Problems Solved

While the first modern railroad car was not air conditioned until 1930, and air conditioning for comfort did not become common until the 1920's, the pioneer installations were made to solve production problems. A New York lithographic plant installed a system early in the century, and apparatus for cooling, dehumidifying, and circulating air went into a Boston chocolate factory in 1906 (and is still in operation). Many textile manufacturing operations need controlled conditions of humidity and temperature. In making penicillin, air conditioning and refrigeration are prominent, for the mold gives maximum output when held successively under a number of rigorously regulated environments. Because many modern metal parts, ranging from ball bearings to marine propulsion gears, require high precision, the expansions and contractions following normal temperature changes often exceed permitted tolerances. More machining and assembly operations are therefore being done in air conditioned areas. Cutting down the dust content of the air prevents marring of surfaces in many plating, painting, and finishing operations. Air conditioning also reduces the annoying corrosion spots that sometimes follow when sweaty hands and fingers touch clean metal surfaces.

"Controlled weather" logically accompanies the susbtantially windowless plant that originated in the 1930's and was a typical form of construction during the war. The continuous walls and roof are slightly cheaper to erect than the conventional types and are tight against the multitude of small leaks in windowed buildings. Windowless buildings are thus both easier to air condition and to heat. The heat given off by the lighting system, machinery, and the occupants sometimes suffices to keep the indoor temperature at comfortable levels when it is near zero outside.

The Question of Water Supply

As air conditioning becomes more common, the problems of many local water supplies are complicated. The equipment needs considerable quantities of cooling water, with the maximum demand coming during the hottest summer months when other water requirements are at their peak. Disposal is also a problem, for the capacity of many sewer systems may be exceeded, particularly after a heavy rainfall. Regulation of water supply and disposal by city ordinance is therefore common. In New York City, for example, large air conditioning systems must cool and re-use the water in some way, e.g., by installation of an evaporative condenser or spray tower. On the western end of Long Island, perhaps the outstanding instance of industrial and municipal dependence on ground water supplies, more than 200 recharge wells return water to the water bearing strata. Since the returned water is warmer than the original ground water supply, the local supply may in time become too warm for cooling purposes. At Louisville, Ky., another area of heavy dependence on wells, cold river water is pumped into the ground during the winter, to be drawn on in summer when the river water is too warm to be used economically.—*from the Industrial Bulletin of Arthur D. Little, Inc.*



SAM LEWIS' PAGE

Informal comment on heating, piping, and air conditioning matters is given in this regular feature by Samuel R. Lewis, consulting mechanical engineer, member HPAC's board of consulting and contributing editors

Short Cycling Causes Heating Difficulties

Practical pointers on troubles caused by short cycling of an oil fired warm air heating plant and an oil fired hot water heating plant and how to correct them

I HAD OCCASION recently to inspect the heating in a rather long single story building. The original heating plant comprised a warm air furnace with conventional air filters, electric fan, and pot type oil burner. The heat distribution was reasonably satisfactory because of the practically continuous heat from the oil burner. This burner, however, tended constantly to clog with carbon and the chimney temperature was so low that odors of escaping products of combustion were objectionable.

The original furnace was replaced by one equipped with a gun-type, mechanically atomizing, high intensity oil burner. The furnace is in the basement under a large, centrally located, first story room in which the thermostat was installed. There are other rooms of considerable size to the north and to the south of the central room.

The thermostat in the central room, when cooler than the desired temperature, starts the oil burner motor, and when the furnace bonnet temperature reaches the preset temperature, the supply fan motor goes into operation.

There are adequate supply and return ducts for every room.

The thermostat in the central room becomes warm very quickly during any ordinary winter day—say in 8 or 10 min. after the oil burner starts—and as a result the burner stops. The supply fan starts to run within about 5 min after the oil burner starts, and may operate for perhaps 10 min after the oil burner stops. The result is that the central room is kept reasonably overheated, while the outlying rooms on the north and south are continually and unreasonably underheated at any hour of any day.

The long ducts leading to the remote rooms are well insulated. They become cool, however, during the long periods of off cycle operation, observed to be from 30 to 45 min when the outdoor temperature is 30 F. The re-warming of the ducts and of the insulation on them requires so much heat and so much time, relative to the heating of the central room, that the remote rooms never do become comfortable.

Apparently the automatic temperature control arrangement, which is generally conventional for forced circulation warm air heating and which may do rather well in a two story compact residence, is ill adapted to a building and plant such as I have described.

A comparable situation with the automatic controls for an oil burning hot water heating system has also appeared. The domestic hot water for lavatories, showers, etc., is warmed by transfer from the boiler water. The boiler heats the building in winter and thus is over-size for domestic water alone. For summer service, the oil burner operation responds to an aquastat in the domestic water.

During hours when the demand is light, the oil burner heats the water in the boiler in a very short time, and cycles frequently—so frequently, in fact, that the combustion chamber and breeching barely get warm, and are so cool that the combustion chamber fails to reach an efficient oil burning temperature.

The answer in both cases seems to be some scheme by which the oil burner combustion rate can be reduced and so that the operating time can be lengthened to such an extent that the chamber will be hot enough to permit efficient oxidation of the gases.

How to Correct the Troubles

In the warm air heating system for such a building, enlightened experience has indicated that the supply fan should operate continuously, with provision for varying the temperature of the air delivered but with constant volume and velocity. Such operation easily can be accomplished by installing a double mixing damper in the warm air discharge duct, controlled by the room thermostat, or preferably by a separate mixing damper similarly controlled by a thermostat in each principal zone.

The oil burner operation responds to the bonnet thermostat to maintain a constant source of air for serving the warm air part of the damper. The other part of the damper receives recirculated but unheated air. The plant that I studied eventually may have to be rebuilt to give controlled zoning after this general idea.

Considerable emergency improvement was effected in the meantime by closing the return air grilles in the central room, so as to reduce short circuiting of the air from that room. This requires all return air to be withdrawn from the north and south wings.

The short cycling of the hot water heating plant was improved by reducing the rate of oil delivery to the burner, and by installing a circulating pump between the boiler and the hot water storage tank. The original aquastat in the tank near its center, became warm and stopped the oil burner while the water in the lower part of the tank was still cool.

The oil burner control was restored to respond to changes in the temperature of the water in the boiler itself and the on-off differential was increased. The little circulating pump operates continuously, so as to gain full advantage of the storage capacity in the tank as well as that of the heat storage in the boiler water.

The over-all result is a much reduced oil consumption and a more satisfactory water temperature.

—RESEARCH PROJECT STUDIES THE FLAME—

Engineers are taking a close look at one of the oldest phenomena known to man—the flame. At Westinghouse in East Pittsburgh a large, modern, expensive laboratory, well-staffed by research engineers, is in operation just to study the mechanism of combustion, which for all its age and seeming simplicity still has many secrets.

The research has numerous aspects. One has to do with flame propagation. Considerable research on rates of flame travel in combustion mixtures has been done elsewhere, but mostly at ordinary pressures — around atmospheric. Not much study has been made of propagation rates at low or high pressures, however. Curiously enough, flame travels relatively slowly through gases—say 2 to 5 fps, unless other factors are brought to bear. It is these other factors that are important. Ways of providing large flame areas, reverse flow, turbulence; effect of pressures, mixture temperatures, nature of fuel, its proportions with air, etc., are undergoing critical study particularly at gas pressures other than atmospheric.

Air flow in chambers burning light fuels is another subject of study. For example, should air come from behind the fuel nozzle? If so, how far behind? If in front, how far in front? Should air be injected radially? At an angle? With a swirling motion? What is the best configuration of air inlet holes? It has already been found, for example, that large holes with relatively low air velocity provide a better combination of flow path and turbulence than small holes and high velocity.

Stability of flames is an important matter. It is desired in gas turbine work, for example, that combustion occur in the wake of an object held in the stream of gases. The flame must neither be blown out or allowed to creep behind the object and move upstream to the source of combustible mixtures. The factors effecting this stability are being analyzed.

One of the most immediately practical phases of combustion research is development of a combustion chamber in which heavy fuel, such as bunker C, can be burned. Here the problem was to develop a burner—small, efficient, with long life, free from carbon deposits and hot spots—in which the fuel could be ignited readily and reliably with a flame stable under a wide variety of loads.

The combustion chamber being used on the locomotive type gas turbine is a result of this study. It is a stepped, nickel-chrome steel tube 36 in. long and varying in diameter from 3 to 4½ in. For its volume the heat release is enormous—about 3 million Btu per cu ft per hr. Although the flame temperatures run around 3500 F, the combustion chamber sleeve remains at about 1000 deg. This is accomplished by introducing cooling air between the stepped sections to maintain a protective blanket along the wall of the chamber.

An important contribution of the new laboratory to combustion is a new type of atomizer. By learning where to introduce air, in what direction, and at what pressure, a fuel spray is obtained that consists of much finer particles than is possible with previous air atomizing nozzles—and, very importantly, it needs only about one-fiftieth as much air flow, even for heavy fuels. The nozzle is particularly adapted to giving good stable performance at starting and light load conditions.

Among other important phases of present research is development of devices and techniques for accurately measuring temperature in combustion chambers. Another major field of research on which much has been accomplished is combustion of pulverized coals.

Practical Pointers on

AIR CONDITIONING PLANT OPERATION

By Donald A. Kepler, Chief Engineer,
New York Stock Exchange Building Co.

Special Drawings a Great Help

THE AIR CONDITIONING operating engineer is especially dependent on mechanical building plans, since so much of his apparatus stretches out into remote places. Conventional building drawings, however, have several faults which limit their usefulness to the operating man . . . . The New York Stock Exchange plans to prepare special drawings for the operating personnel, and while this will be a lengthy process and perhaps costly, if they serve to improve the effectiveness of the operating technique they should be well worth the trouble

Most operating people appreciate a good set of mechanical building plans. The air conditioning operating engineer is especially dependent on drawings since so much of his apparatus stretches out into remote places. Moreover, a set of prints gives the operator a truer representation of conditions than an actual physical survey, since architectural devices often mask the ungainly features of mechanical connections.

Faults of Conventional Drawings

Conventional building drawings, however, have several faults which limit their usefulness. At the New York Stock Exchange, our drawings are of the conventional type but we expect to have some day a set of special air conditioning operating drawings. In the preparation of these drawings, there are some things we will want to include that customarily have no place on building drawings. Other things we will want to show in a totally different manner.

One of the present difficulties is that we have no tracings—just blueprints. This makes it difficult to indicate alterations as they occur and, at the same time, to keep a running record of past changes.

Another disadvantage of conventional drawings is inherent in the fact that they initially were prepared for some purpose other than operating. They were prepared primarily for construction purposes. Having a record of construction details is important to us when changes are contemplated, but this does not completely fill the needs of the operating man.

A third disadvantage of conventional drawings is that several sets of plans are required to cover completely an apparatus layout. In addition to the duct layouts and piping arrangements, electrical and plumbing drawings are a necessary part of the air conditioning picture. Trying to read from two to three sets of drawings concurrently is, to say the least, confusing. They are cumbersome, too.

The purpose of the special operating drawings I have in mind is to eliminate these disadvantages and to improve the utility of the drawings and their accuracy as well.

Pencil tracings on paper will be adequate for our needs. They can be altered readily and, if they are kept near at hand, they can be kept up-to-date. A set of prints can be used as ready reference material, and a file of prints showing alterations can be kept as a record.

What to Include in Operating Drawings

The operator's needs will determine exactly what goes into the operating set, and we will feel free to use whatever device best illustrates the particular condition. For instance, where we have a complex layout such as the refrigeration plant piping, where two drawings are necessary to cover the territory thoroughly, we will use two. One will show the construction features as they are; the other will show only a diagrammatic scheme. Numbered valves, indicated on both drawings, will tie the two drawings together functionally and will relate the drawings to the plant itself.

While we are at this, we will include on the diagram general operating instructions and details—such as capacities and ratings of the individual pieces of equipment under conditions of actual operation.

Another item we intend to include right on the drawings is a list of parts and parts numbers with specifications and any other information that would be required to reorder supplies and repair parts. This will eliminate the need for a separate file covering such items as motors, drives, controllers, starters, bearings, shaft packing, filters, traps, control valves, and indicating or regulating instruments—not to mention the lesser elements that go to make up the parts. Individual sheets of instructions are frequently mislaid or lost, and they cannot always be replaced.

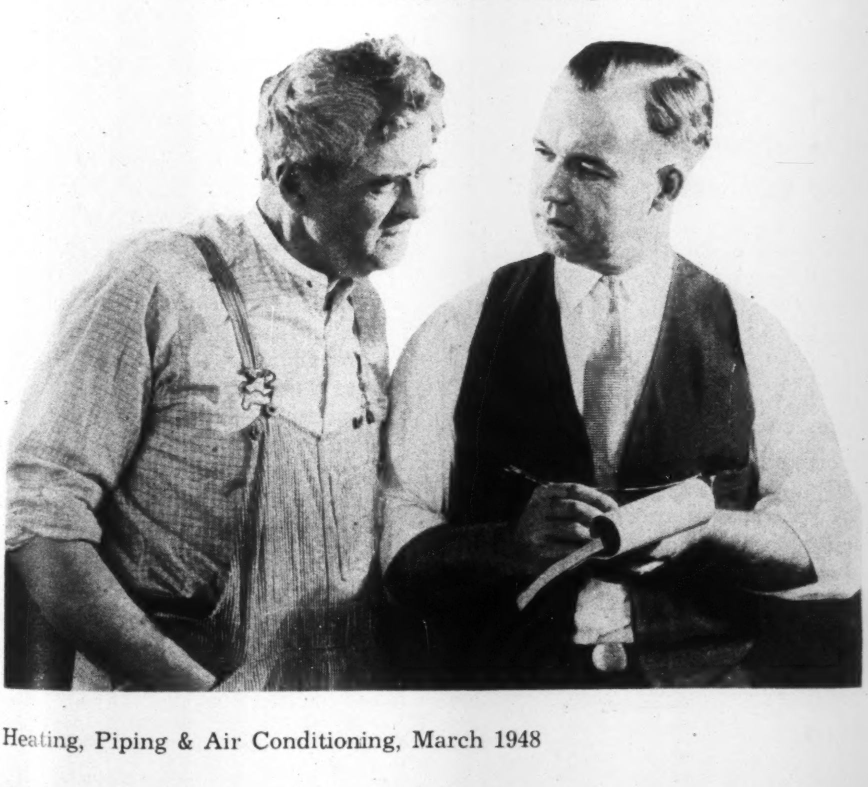
Load Summaries for Each Area

When we come to our duct layout drawings, we intend to check duct runs against shop drawings, and we hope to show air quantities as actually measured. We expect also to include a heating and cooling load summary for each separately controlled area, so that at any future time a complete analysis can be reconstructed. We will be especially careful to show the locations of access doors to fire dampers and splitter dampers. We will refer to these locations in "Schedules of Dampers" which will be a part of the drawing.

As with the usual building drawings, floor plans will form the basis of the special set. Exactly how much information can be included on any one floor plan will depend on the complexity of the apparatus on that floor. We intend to have a one-eighth arrangement drawing for each floor to start with. Where an air unit is to be shown, a separate sheet will be added in order that details of the unit, dampers, coils, piping, and controls can be shown in larger scale—say, 1/4 in. scale. Here we will use sections and elevations freely. Where small-scale inserts will serve to explain an obscure feature, they too will be used. On floors where there is very little or no apparatus, just ductwork or piping runs, one plan can show in addition electrical and plumbing lines.

There seems to be a hesitancy among draftsmen to use explanatory notes freely on their drawings. Perhaps they feel that a lot of notes is a reflection of poor draftsmanship. If reference numbers in small circles are employed, there is almost no limit to the number of notes that can be included without impairing the clarity of the drawing. An example of the extensive use of notes is the control diagram. On one such drawing I have prepared, the explanatory notes occupy more space than the drawing itself. We have gone into considerable detail in the interpretation of our control diagrams so that the source of any operating trouble can be detected and corrected immediately. The operator should be able to tell at a glance which instrument is doing the controlling, what effect it *is* producing, and what effect it *should be* producing.

A record of construction details is important when changes are contemplated.



We are making every effort to gather all of this information now, to have it assembled even before our new equipment is in operation. It is not that we expect any immediate operating trouble, but simply that the records are now fresh and readily available. If we wait until we get around to the drawings themselves, some of the channels of information to our equipment suppliers may not be available to us.

We know that the preparation of these drawings will be a lengthy process, and it may be costly—but if special operating drawings serve to improve the effectiveness of our operating technique, they will be well worth the trouble.

MEASURE TEMPERATURES WITH SOUND WAVES

How sound waves can be used to measure upper atmosphere temperatures was described recently by Dr. Everett F. Cox, Naval Ordnance Laboratory, Washington, D. C., at a joint meeting of the American Physical Society and the Institute of Aeronautical Sciences at Columbia University, New York City.

Around a source of loud noise, such as the explosion of an ammunition dump, there are alternate rings of noise and silence, Dr. Cox said. No noise may be heard at one place and a few miles farther away windows may be shattered by sound waves.

This condition, Dr. Cox explained, is caused by layers of hot air in the upper atmosphere which serve as reflectors. "Since sound waves are bent back to the earth by the hot layers of the upper atmosphere, measurements of sounds received at great distances from explosions can be used to calculate temperatures of the earth's outer air layers," he said.

Temperature values calculated from such studies, Dr. Cox said, show an ozonosphere peak of 70 F at 35 miles altitude, a dip to minus 150 deg at 45 miles, then a temperature rise to 260 deg at 100 miles above the earth.

What's Best Way to Save
FUEL FOR HEATING?

There are many, many things that can be done to save fuel required for building heating, but I wonder if it is possible to say what the one most effective method of heating fuel conservation would be?, asked "D.D." in a question published in the January issue. "I'd be interested in any comments from readers as to what management of the 'average' small industrial plant or commercial building should look for when the possibilities of fuel conservation are being considered," he continued.

Some of the answers to "D.D.," which have been submitted by readers of HPAC, follow.

CHECK LIST HELPS FUEL CONSERVATION

Briefly, the answer to "D.D.'s" question is "no." His question is indeed a general one, since the best solution for saving fuel in one building may not be the answer to the problem in some other building.

To arrive at the fundamentals of fuel conservation, it is suggested that "D.D." ask himself two questions:

1) What kind of a job does the heating plant do?

2) What happens to the heat supplied to the building?

To give intelligent answers to these two questions for a given building, an engineering estimate should be made. With pertinent data available the answer to "D.D." could very well be "yes," but lacking such data a definite solution is impossible. I have, however, compiled the following check list for his consideration:

Is the fuel for which the heating plant was designed being used?

Does the heating plant utilize the heat supplied to it? In other words, does the heat produced go to the building or up the stack?

Is the technique of operating the heating plant such that it meets the load and yet fuel is not wasted? (Excess air is the chief thief of combustion.)

Is the system in good repair?

Are different parts of the building or plant zoned?

Is the heat load reduced during periods when the plant is shut down?

If open loading docks are present, is every reasonable effort made to reduce the time doors are open?

Is the ventilating load too large for the size of the plant, the nature of the product, and the working conditions of personnel?

Is wall and ceiling construction such that further insulation would be uneconomical?—F.B.M.

COMPETENT ENGINEER BEST FUEL SAVER

In answer to "D.D.'s" fuel conservation question, in my experience with steam heating plants, steam traps in poor condition are the No. 1 fuel waster. During the fuel rationing period, I saved as much as one-third of the fuel used by reseating and conditioning radiator and end of line traps.

Incorrect burner adjustment, false drafts, and lack of insulation are the No. 2 fuel waster in a steam plant, and rate No. 1 in water heating plants.

The boiler rooms in the majority of steam heating plants in apartment houses are fairly well taken care of, but seldom is proper thought or service given to traps. A good many of the apartment managers or janitors who operate these plants, since they are automatic and seldom require the service of a competent engineer, do not know the function or purpose of a steam trap. That little gadget setting at one end of the radiator probably hasn't been touched since it was installed years ago.

On hot water jobs, I believe insulation or lack of proper insulation is the No. 1 fuel waster. False drafts and burner adjustments are largely taken care of by oil burner

DO YOU HAVE DATA ON ROOF SPRAYS OR FLOODING TO CUT SUN HEAT?

You are invited to comment on the following question from "K.P." Suitable discussions of this matter will be published, and paid for at regular rates (with additional payment for sketches). Address The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.

"There was published in HPAC some time ago a complete report on solar heat gain through roofs, and the effect of water sprays and water ponds in reducing this part of the air conditioning heat load.

"I should like to ask if readers of HPAC have any data they could furnish me on specific applications of roof sprays and/or ponds for this purpose. If available, I'd appreciate information on how much the solar heat load was actually reduced, and practical suggestions for the best way to spray or flood roofs. Are there any 'pit-falls' to watch out for?"—K.P.

service men. Poor valves and poor circulation contribute a great deal to fuel waste, as do scaly boilers that haven't been blown off or cleaned in years, and dirty flues that have been brushed with the same worn flue brush that does nothing more than brush out the soot.

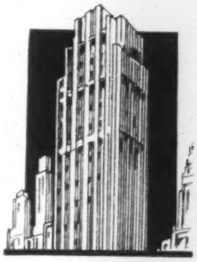
That is my experience after spending 26 months taking care of the heating for 30 apartment houses for a corporation owning apartments from Washington to California.

There are many, many things that can be done to save the fuel required for heating commercial buildings, small industrial plants, and apartment houses. The greatest of these is a periodical check of the entire system by a competent engineer.—C.N.B.

INSULATION OFFERS BEST POSSIBILITY

Considering "D.D.'s" question on the best way to save heating fuel, there may be several correct answers depending on the type of building, equipment, and fuel. However, by making some assumptions, we may approach a method of solution for a given set of conditions.

Let us suppose the building is heated by steam from a coal fired boiler and that the entire heating system is contained within the building being heated. Under these conditions there are only two factors bearing on fuel consumption to be considered—boiler efficiency and building heat losses.



Boiler operation should be checked and necessary adjustments made to secure the most efficient and complete combustion and lowest stack temperature possible with the equipment in use. As the plant is entirely within the building, the only heat losses at the boiler will be up the chimney or in the ash.

On the other hand, the heat losses from the building are many and varied. There will be losses from the walls, floor, roof, windows, doors, ventilators or other openings; possible losses from hot water escaping through fixtures or drains; possible stratification of air necessitating higher average temperatures with consequent larger building heat losses being the result.

Of all these losses those most easily corrected are the leaks of water or air, but in most buildings the predominating heat losses are through walls, roof, and glass. These can only be reduced by suitable insulation and double glazed windows.

A client recently furnished me with a set of plans for a proposed building and asked that an estimate be made of the operating cost of various heating systems using all of the available fuels. These operating cost estimates ranged from $420 to $960 for the heating season.

A complete analysis of the building heat losses indicated that proper insulation would reduce the cost of fuel 40 percent and that the addition of thermal glass would result in a further saving of 12 percent.

In my opinion, the greatest possible saving in fuel in most buildings can be secured by proper and thorough insulation.—D.R.S.

SMALL CHANGES SHOW BIG RESULTS

In the January issue of Heating, Piping & Air Conditioning, "D.D." asked for the one most effective method of conserving fuel in heating. In the present state of our fuel supply this is a good question as it is most important that we get the most out of the fuel that is used for heating.

As heating plants are all different they cannot all be expected to need the same treatment. If there is to be any "one most effective method" it must be in the approach to the problem, in the investigation and the diagnosis of the reason for the plant burning more fuel than it should.

The one most important thing is to not take anything for granted. Don't take it for granted that the radiators are large enough to heat the rooms or that the boiler has the capacity to heat the radiators. Check the heat loss of the various rooms and the capacity of the boiler and find out for sure.

If last year's fuel bills are available find out how much fuel was burned and check that against last year's degree days. Don't take the owner's word for it as he is probably thinking in dollars and not in gallons, pounds or cubic feet. As all prices have gone up it may be price rather than consumption that is wrong.

QUESTION OF THE MONTH

YOU ARE invited to submit a heating, piping, or air conditioning question for publication here. You are also invited to submit answers to previously-published questions from others. Those published are paid for at regular rates. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

The writer has been very interested in this subject since 1931 and has had some success in getting fuel bills down to somewhere near what they should be. That experience has been mostly with oil but the findings would apply to other fuels.

A bank converted from hand fired coal to oil and installed a rotary cup type of burner. The burner produced a CO_2 reading of 11.5 percent and a 550 F stack temperature but it was soon evident that the fuel bill would be too high. It was observed that every time the thermostat called for heat the burner ran the steam pressure up to 5 lb, shut down on limit and went up to 5 lb the second time before the thermostat was satisfied. A new adjustable air valve on the radiator and a limit setting of 3 lb allowed the thermostat to be satisfied on the first run but the rest of the building was cold. About 50 new air valves cured the trouble and showed a 24 percent drop in fuel consumption.

In most cases there will be no one outstanding defect whose correction will produce the desired reduction in operating cost. A number of small changes will often show big results.

The equipment needed for this work is a CO_2 tester, a draft gage, a flue thermometer, a broad knowledge of heating, and a flair for trouble shooting. The results will range from no improvement at all to a spectacular 50 percent or more. The average for a fairly large number of jobs should be about 20 percent.—R.H.M.

Card No. 63
Job No. ___

___ INSTRUCTIONS: All switches and other operating devices shall be clearly and neatly marked as to purpose and the Owner's Representative shall be instructed in the method of operation and care of the system. Operating instructions shall be typed or printed and permanently installed in a frame in the equipment room on the electrical control panel board.

(for electrical controls)

All the control wires shall be tagged with a distinctive number on a non-metallic tag. An electrical control diagram shall be furnished with the markings to correspond with the numbers on the wire tags and control equipment, so that the system can be traced by any electrician.

(for pneumatic control system)

A schematic piping control diagram shall be furnished and mounted on the control panel. This diagram shall have the equipment and piping marked on it to correspond to the actual markings on the equipment.

Card No. 64
Job No. ___

___ GUARANTEE: This Contractor shall guarantee all equipment, parts, and workmanship to be free from defect for a period of one year from date of acceptance of the system as a whole and during such period furnish all replacements, service, and adjustments which may be required in his work or in connection with the equipment installed.

The compressor and equipment attached to the cooling system shall be guaranteed against loss of refrigerant in excess of 5 percent of the total charge for a period of two years from date of acceptance of the system.

He shall guarantee the duct work to be absolutely airtight with no leakage either into or out of the system except at the registers and grilles provided for that purpose.

Card No. 65
Job No. ___

___ STRAINERS, REFRIGERANT: Furnish and install a liquid line strainers in the refrigerant liquid line before each solenoid valve and within 3 feet of the direct expansion coil manifold. This These strainers shall be of the ___ "Y" type similar and equal to those manufactured by ______________ ______________ or of the flanged type which can be removed from the line without moving the piping on either side of the strainer. No flare fittings shall be permitted on the strainers.

Within 6" of the compressor in the suction line shall be installed a suction line strainers of the flange type which can be removed from the line without moving the line on either side of the strainer.

The All liquid line strainers shall be of the size of its their respective lines or larger as specified on the plans. The suction line strainers shall be of the size of the compressor suction fittings or common suction line as shown on the plans.

All strainers shall be of brass with sweat fittings and shall be designed for use with "Freon 12" __________ refrigerant.

Card No. 66
Job No. ___

___ STRAINERS, STEAM: Install where shown on the plans and before each trap at the main drips and blast coils a strainer of the type for threaded pipe. This strainer shall have an iron a brass body with a brass screen and shall be designed for ___ 125 psig working pressure.

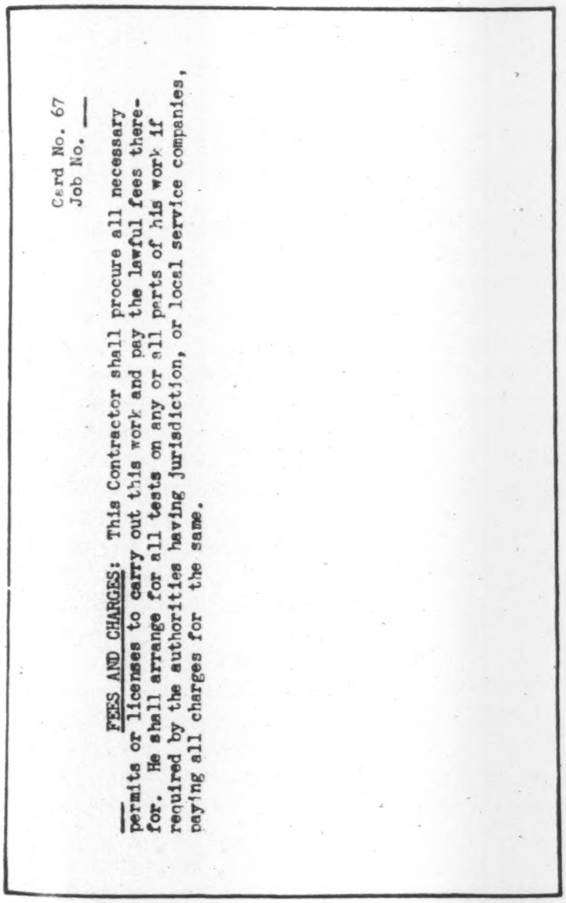
The strainer screen shall be made of not less than ___ 0.023" dia. wire, having twelve meshes per inch.

DATA SHEET

Simplified Procedure for SPECIFICATION WRITING

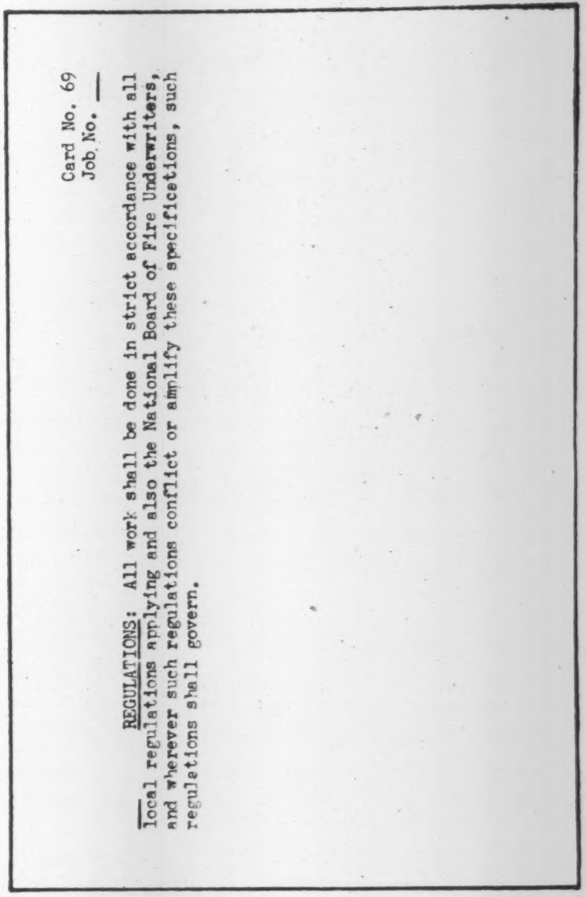
To meet a number of requests from readers for more information about the method described in George W. Campbell's article, A Simplified Procedure for Specification Writing, in the April 1946 HPAC, it was decided to run as a supplement to this article a series of specification cards which are used by the firm of Urdahl and Everetts, consulting engineers, in their Washington, D. C., and San Francisco offices. Mr. Campbell is employed in the Washington office.

Several of the cards have been published (and details of their use explained) in the June 1947-February 1948 issues inclusive, more appear this month, and others will follow. These specifications are not to be construed as recommendations to other consultants but to illustrate this card file used by Urdahl and Everetts.



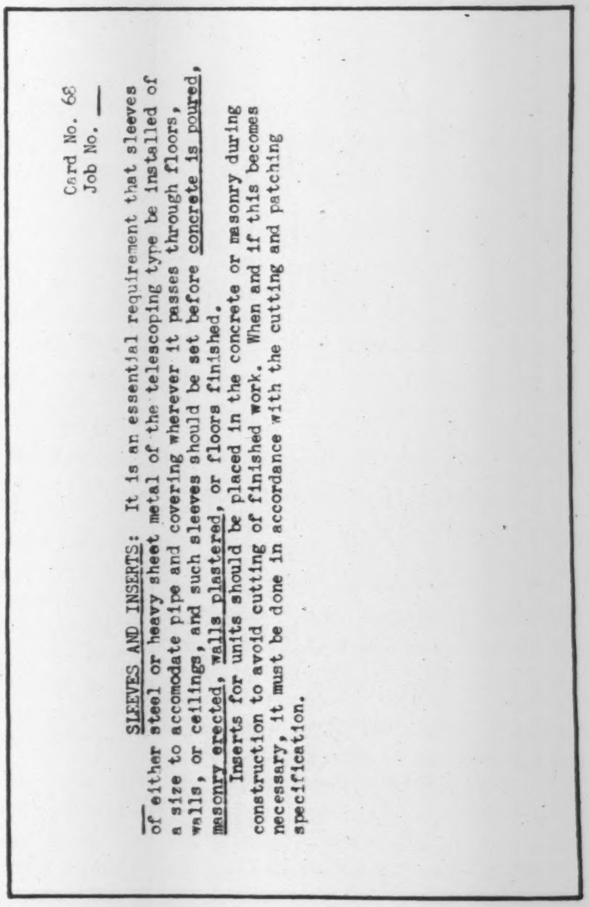
Card No. 67
Job No. ___

___ FEES AND CHARGES: This Contractor shall procure all necessary permits or licenses to carry out this work and pay the lawful fees therefor. He shall arrange for all tests on any or all parts of his work if required by the authorities having jurisdiction, or local service companies, paying all charges for the same.



Card No. 69
Job No. ___

___ REGULATIONS: All work shall be done in strict accordance with all local regulations applying and also the National Board of Fire Underwriters, and wherever such regulations conflict or amplify these specifications, such regulations shall govern.



Card No. 68
Job No. ___

___ SLEEVES AND INSERTS: It is an essential requirement that sleeves of either steel or heavy sheet metal of the telescoping type be installed of a size to accomodate pipe and covering wherever it passes through floors, walls, or ceilings, and such sleeves should be set before concrete is poured, masonry erected, walls plastered, or floors finished.

Inserts for units should be placed in the concrete or masonry during construction to avoid cutting of finished work. When and if this becomes necessary, it must be done in accordance with the cutting and patching specification.

Proper Sizing of REDUCING VALVES

With much interest, I have read John H. Clarke's series of articles on practical piping problems which has been appearing for some time in your publication.

Since I am employed in the piping design section of a large shipbuilding concern, the articles have been particularly timely as far as I am concerned.

The January issue devoted quite a bit of space to the necessity for proper sizing of reducing valves and to the condensate tests which he made. Mr. Clarke's conclusions relative to improper design and sizing of reducing valves may not be correct due to the following factors which may not have been considered:

1) Reducing valves could not be expected to operate satisfactorily in parallel with an opened bypass. The opened bypass should reduce the operating pressure differential between the reducing valve inlet and outlet and cause the valve to close regardless of differential pressure adjustment facilities on the valve.

2) If the bypass was opened and the reducing valve was inoperative, then the measured condensate should have indicated all the condensed steam needed by the coils to heat the cargo unless:

a) The pipe sizes were too small.

b) The pipe lines were clogged with scale or other foreign matter.

c) There was insufficient heating surface in the coils.

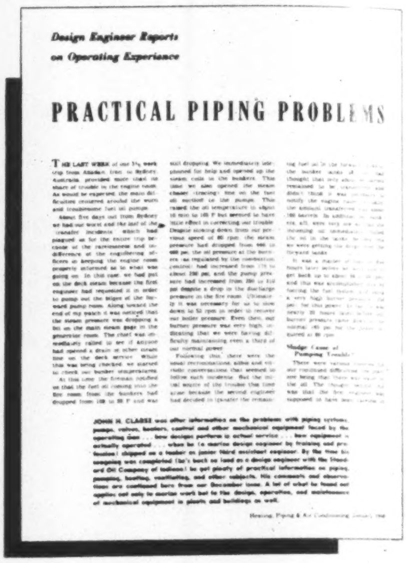
The temperatures of the steam supplied the coils, the condensate from the coils, and of the heated cargo would, in my opinion, be necessary before it would be possible to make correct evaluation of design defects in the system.—I. C. **Wilkins**, Hilton Village, Va.

Reply by Author—Perhaps Mr. Wilkins has overlooked several pertinent points with respect to the check on the capacity of the reducing valves. It would not have been necessary to open the valve bypasses had the valves been capable of passing sufficient steam to maintain the proper downstream pressure. Actually, they could not do so despite being provided with the design upstream pressures (and temperatures). As long as the downstream pressure was below the control setting of the valve, it would be wide open, and the use of the bypass would in no way interfere with its operation.

This situation would be no different than where two pressure reducing valves operate in parallel, the second opening at a predetermined point below the control setting of the first valve. On the ship, the heating coils were using all the steam they could get, as evidenced by a severe drop in pressure at the reducing stations until sufficient steam was bypassed to bring the pressure up to the design conditions.

In rechecking several manufacturers' catalogs, it was found that with the best valve design for the existing conditions, a 2 in. and a 4 in. valve would have provided the estimated maximum of 26,000 lb per hr. Our 3 in. valve didn't quite make the grade at the capacity of 16,000 lb per hr. Our 4 in. cargo heating valve didn't come even close to handling this load. In my article, it was mentioned that the valves on the ship did not meet the estimated requirements by much more than half. Actually they didn't do *that* much because the 16,000 lb per hr *was with the bypasses partially opened for each valve*—only slightly for the first valve, considerably for the second reduction.

For Mr. Wilkins' information, the initial steam condition was about 425 psi and 500 F (boiler drum pressure was 440 psi), and the pressure at the cargo heating reducing valve was 125 psi, with about 100 F superheat. The returning condensate was at 160 F, indicating that it was being considerably undercooled. The *initial* oil temperature would have been very close to the sea temperature, or around 62 F. The final oil temperature was about 90 F. When the system was first started up, only about 10 psi (and then, later, 35 psi) was maintained on the coils for about 24 hr. When condensate finally began to come back to the inspection tank, it was cool to the touch. The condensate temperature came up slowly as the system was opened up and as the coil pressure was increased. But it should be kept in mind that not all of our tank coils were in use, and that, according to our information, none of the steam valves was wide open on the coils which were in use.—John H. **Clarke**, Lansing, Ill.



Design Engineer Reports
on Operating Experience

PRACTICAL PIPING PROBLEMS

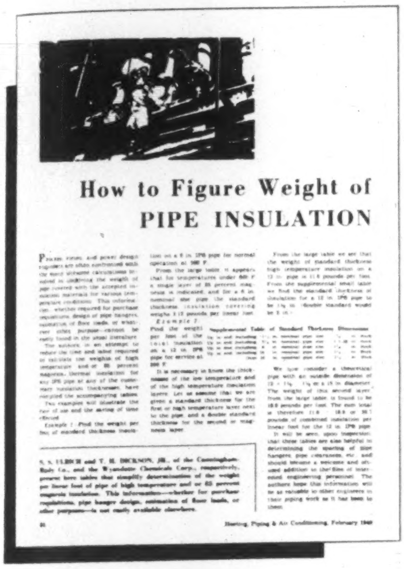
FIGURING WEIGHT OF PIPE INSULATION

Regarding the article on How to Figure Weight of Pipe Insulation, published in the February issue, I have two criticisms.

The first is in connection with the assumed density of magnesia. I believe 16 lb per cu ft is somewhat higher than the material currently being manufactured; however, that is minor, and is on the conservative side. Also in regard to the magnesia, I think it would be wise to state the thickness dimensions for double standard as well as standard. Please see page 119, October '47 HPAC.

Insulation Thicknesses

My principal criticism is in regard to the indicated sizes for high temperature material. High temperature material is not manufactured in the so-called standard and double standard thicknesses. It is manufactured in 1½ in. and 2 in. thicknesses for pipe sizes up to and including 2½ in.; 1½ in., 2 in., and 2½ in. for 3 in. through 4½ in. pipe size; and 1½ in., 2 in., 2½ in., and 3 in. thicknesses for 5 in. pipe size and up. These are nominal thicknesses and not actual; therefore, it would seem to me that it might be advisable to have separate tables, one for magnesia and one for high temperature material.


How to Figure Weight of PIPE INSULATION

The explanation for Example 2 of the article is a little difficult and I think it could be made simpler if for each nominal thickness of high temperature material, the outer layer nominal pipe size, could be given. In other words, for 2½ in. pipe size, nominal 1½ in. thickness, high temperature actual thickness 1 5/16 in., would have a 5 in. pipe size magnesia outer layer.—**Utley W. Smith**, manager, Magnesia Insulation Manufacturers Association, Washington, D. C.

Reply by Authors—We are pleased to have Mr. Smith's remarks concerning our material on pipe insulation.

As Mr. Smith pointed out, our value of 16 lb is a conservative figure, but we chose that value as the maximum figure we found in various manufacturers' catalogs.

The principal criticism Mr. Smith offers is that our table as set up for high temperature insulation is not entirely in accordance with the sizes generally manufactured. We believe that the use of actual thicknesses will prove satisfactory, even though the material is usually furnished in nominal rather than actual thicknesses.

The purpose of the table is to present in compact form for drafting room use a set of insulation weights. As such, we feel a single table to be superior to the same information in two tables.

The expanding of our supplemental table to include the thicknesses of "double standard" insulation, we agree, would be desirable.

We cannot agree with Mr. Smith's comment concerning our Example 2. The difficulty he refers to is due to the statement of the problem, not its solution. We believe that generally the insulation specifications as used by pipe designers are in the form we used in the example, rather than the admittedly simpler form suggested by Mr. Smith.

We wish to thank Mr. Smith for his helpful criticism, and hope our reply has helped to justify some of our differences.—T. H. **Dickson, Jr.**, Wyandotte Chemicals Corp., Wyandotte, Mich., for the authors.

Air Conditioning Buyers Know Lots About It That *"Ain't So"*

"OPEN FOR DISCUSSION"

DO YOU HAVE something to say about any of the articles published this month? An additional comment, or perhaps a question on some point? We follow here the custom of engineering society meetings in allowing a period for discussion following presentation of a paper. You are invited to contribute your views. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

WHAT ARE THE PROPER AIR CONDITIONS?

We have noted the article in the January issue of HPAC, Air Conditioning Buyers Know Lots About It That "Ain't So," by H. E. Wheeler.

After reading this article as it may apply to office, classroom, and theater installations, it seems that Mr. Wheeler prefers air conditioning equipment designed to maintain a constant inside temperature of 75 F and approximately 50 percent relative humidity, without regard to outside design conditions. We are wondering if he did not mean 75 deg effective temperature instead of 75 F DB, as would be the general interpretation from his article.

Since the effective temperature is dependent on the dry bulb, wet bulb, and the velocity of air movement, a room condition of 75 F DB and 50 percent RH with say, 100 fpm air velocity, would result in an effective temperature of 69 deg, which appears to be very low.

Another way to interpret Mr. Wheeler's article is that he may agree with some designers who favor inside conditions resulting in an inside effective temperature of 15 deg less than the outside effective temperature. If this assumption were correct, then the resultant inside effective temperature of 69 deg indicated above could have been based on an outside condition of 100 F DB, 77 F WB with a corresponding effective temperature of about 84 deg, or an inside dry bulb temperature of 25 F below the outside dry bulb temperature. But if we interpret Mr. Wheeler correctly, he would still be in favor of a 75 F DB inside temperature with 105 deg

"OPEN FOR DISCUSSION"

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or 110 deg DB outside condition (providing these were normal outside design conditions for the locality).

Most of us can remember the uncomfortable experiences—from the days when theater air conditioning was new—which we encountered when leaving a theater conditioned to 70 or 75 F DB, when the outside temperature was 100 F or more. People apparently physically fit have been known to faint after leaving a 75 F DB conditioned space, for a 100 F DB outside condition.

Good engineering practice, it seems, should also consider the costs of results obtained. Therefore, assuming an outside condition of 100 F DB and 78 F WB, would it be considered good engineering practice to design office, classroom, or theater installations for 75 F DB when it will require approximately 50 percent more machine capacity than if designed for 85 F DB, or a 15 deg differential? Is the trend established to where the buying public is now actually buying the greater capacity systems in order to secure a 75 F DB inside condition, or are the majority of air conditioning systems still being installed with approximately 15 deg differential?—JOHN O. JOHNSON, mechanical engineer, air conditioning and refrigeration, Air Training Command, Barksdale Field, La.

REPLY BY AUTHOR—It seems necessary to clarify my position if it can be so completely misunderstood. I naturally am referring to a 75 F dry bulb temperature with a 50 percent relative humidity. These conditions are practically identical with the optimum conditions for summer recommended by the ASHVE's Heating, Ventilating, Air Conditioning Guide.

I certainly do not agree with engineers who design for a 15 deg differential from the outside temperature, and my article, I believe, said so explicitly. If we had installations where we maintained 85 F inside when it was 100 F outside, our telephone would ring off the hook with complaints.

Actually, it is only because there are allowances in safety factors in our selections of equipment that we are able to keep customers satisfied as it is. I believe most of our customers are maintaining temperatures lower than 75 F dry bulb regardless of the outside temperature.

The statement by Mr. Johnson that people apparently physically fit have been known to faint in passing from 75 F dry bulb space into 100 F outside air is probably true, as people have been known to faint for no reason whatever. The healthiest man I ever knew fainted the first time he went into a doctor's office to get a certificate, although the doctor was not even there and was not planning to do anything to him. If you tell people that they should faint in moving from 75 to 100 F atmosphere, a certain number of them are so emotionally constituted that they will faint.

On the other hand, if we were so delicately balanced that this change of temperature were serious or important, people would faint in droves in the winter when passing from an outside temperature of 0 to an inside temperature of 70F, as I attempted to point out in my article. I believe it is a mistake to perpetuate the myth of air conditioning shock. The best information obtainable to my knowledge indicates that there is not one authenticated case of it on record in medical history.

Theater air conditioning is a subject by itself that I did not attempt to deal with in my article. Theater owners in general are in the well-informed class on the subject of air conditioning. The problems of air conditioning a theater, or any place where people are grouped in masses close together, are completely different than in lightly occupied spaces such as offices.

In this field, practice in the past has perhaps been influenced by first costs rather than by ideal consideration.—H. E. WHEELER, president, Air Comfort Corp., engineers and contractors, Chicago.

ONE PIPE AND TWO PIPE STEAM HEATING

ANENT THE "feud" between Samuel R. Lewis and other experts on the relative merits of one pipe and two pipe steam heating systems (pages 130-134 of the January issue) I wish to point out a very satisfactory installation of the former.

This installation was equipped with packless radiator valves and vacuum type air vents, thus forming a single pipe vapor system which operated at subatmospheric pressure with a low rate of firing. During mild weather, low radiator temperatures could be obtained with circulation of vapor under partial vacuum. During the night period of banked fire, a high vacuum existed in the system and vapor or steam was circulated rapidly upon opening of fire, providing quick heating up due to no time being required for venting of air from the system. A compound vacuum and pressure gage gave an interesting check on tightness and operation of the installation.—J. G. MENCH.

WANTS MORE DATA ON STEAM TRAPS

THE REPLIES published in the February HPAC to my question about steam traps are excellent. I have one comment on "S.R.H.'s" article. From his admonition about providing cooling legs, one would assume that a cooling leg is an essential item with every trap. As we know, this is not the case; a cooling leg is the exception, not the rule.

However, neither article gives the complete story. I would like to see a comparison made of the performance of ball float traps and bucket traps, with expressions covering the following controversial points:

1) Possibility of steam leakage.

2) Temperature of condensate.

3) Ability to drain evenly a blast coil operating with a widely fluctuating steam pressure.

4) Ability to remove air from a blast coil, with frequent on and off steam cycles.

5) Life expectancy.—F.S.

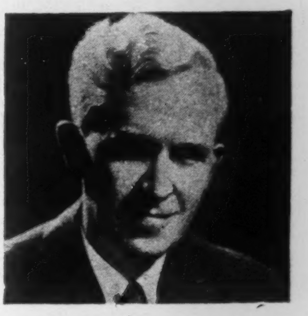
Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Baldwin M. Woods
President
Berkeley, Calif.

Record Attendance of ASHVE Members at 54th Annual Meeting



G. L. Tuve
President-Elect
Cleveland, Ohio

With a registration of more than 1800, the 54th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS was held at Hotel Commodore, New York, February 2-5, 1948.

Meetings of the Council, Committee on Research and many of the Technical Advisory Committees preceded the formal opening of the Meeting. During the four days the Chapter Delegates held three meetings, and the Nominating Committee held its organization meeting.

The first session was called to order by Pres. Baldwin M. Woods, Berkeley, Calif., in the grand ballroom of the Hotel Commodore, and Pres. M. C. Giannini, New York Chapter, gave a brief message of greeting to the members, to which President Woods responded. Walter Heibel, general chairman, Committee on Arrangements was introduced.

In his President's Report, Dr. Woods commented in detail on the activities of the Society and gave some figures on the extent to which members participated in the work of the Society. He mentioned that the Council held five meetings during the year and described the work of the several Council Committees and those Special Committees dealing with the revision of the Constitution and By-Laws, and the Special Committees on Business Practices and Publication Policies. He also indicated that a pension fund had been inaugurated and reported with satisfaction on the accomplishments of the Committee on Promotion of Research and the Financing of the Research Program, the activities of the Chapter Relations Committee, and the importance of the Guide Publication Committee's work.

L. E. Seeley
Treasurer
Durham, N. H.

President Woods thought it would not be surprising if recommendation in the direction of increased dues might prove necessary in the future, as the Society is operating under a very low rate which had been reduced during the depression of the thirties.

President Woods expressed appreciation for the assistance of the members, chapters, committees, the Council, and the staff during his administration, and pointed out that "the Society is only as strong as the participation which it receives from its membership and judged by this standard it has an outstanding present and great promise for the future."

A report of the Society's financial condition was given by the Society's

Treasurer, John F. Collins, Jr., and Secretary A. V. Hutchinson read the Report of the Council and the Report of the Secretary.

The Report of the Committee on Constitution and By-Laws was presented by S. H. Downs, Kalamazoo, Mich., chairman, who pointed out that the new Constitution was voted on by the membership after presentation at the last Annual Meeting. The revised By-Laws were submitted to the members in advance and were presented for consideration and adoption at this meeting. After pointing out the significant changes, a vote was called for and the amended By-Laws, as submitted by the Constitution and By-Laws Committee, were adopted.

Following the presentation of two technical papers the group adjourned for luncheon which was held in the grand ballroom and was featured by an inspiring address by William E. Haskell, assistant to the president, New York Herald Tribune, whose subject dealt with international affairs.

At 2:00 p.m. on Monday, the 8th International Heating and Ventilating Exposition was opened at Grand Central Palace, and during the week 40,000 visitors saw the four floors devoted to exhibits of heating, ventilating and air conditioning equipment.

At the Tuesday morning session a Report of the Tellers of Election was given by C. S. Koehler, chairman, as given below.

The papers on Tuesday morning covered the subjects of air distribution. Tuesday afternoon, the entire session was devoted to panel heating discussions, and on Wednesday solar heat transmission and air cleaning methods were given. On Wednesday afternoon a symposium on the heat pump for year 'round air conditioning drew a capacity audience.

At the concluding session on Thursday, winter design temperatures and climatological data were the subjects discussed.

The annual banquet was held in the grand ballroom of the Hotel Commodore and Randolph H. Carpenter was toastmaster, and William B. Stout gave an entertaining talk on *These Human Miracles.* Homer Addams, charter member of the Society, presented the Past President's Emblem to Dr. Woods.

Council Meetings

The final meeting of the outgoing Council was held on February 1, and among the important actions taken were approval of the following: (1) participation in a conference organized by five California universities with the Society's California Chapters cooperating; (2) further payments to reduce the mortgage on the Laboratory property as funds become available; an increased price for the HEATING, VENTILATING, AIR CONDITIONING GUIDE 1948; (3) a charter for the organization of a local chapter at Shreveport, La.; (4) continued participation in the work of the *American Standards Association*; (5) receipt of a comprehensive report from the Special Committee on Business and Financial Policies, and approval of four of the recommendations and deferment of the remainder for later discussion; (6) the adoption of resolutions of appreciation to President Woods and other retiring Officers and Council members.

Report of Tellers

Vote for Officers and Council	Proxy	In Person	Total
President. G. L. Tuve, Cleveland, Ohio	1637	7	1644
1st Vice Pres., A. E. Stacey, Jr., Syracuse, N. Y.	1634	7	1641
2nd Vice Pres., L. T. Avery, Cleveland, Ohio	1607	5	1612
Treasurer, L. E. Seeley, Durham, N. H.	1620	7	1627
Vote for Members of Council			
D. M. Allen, Kansas City, Mo.	1548	7	1555
F. A. Hamlet, Montreal, Que.	1501	7	1508
C. S. Leopold, Philadelphia, Pa.	1523	7	1530
H. E. Sproull, Cincinnati, Ohio	1520	7	1527
TOTAL BALLOTS RECEIVED	1754	7	1761
TOTAL LEGAL BALLOTS	1645	7	1652
INVALID BALLOTS			109
Scattering votes for: 2 other Candidates for President 8 other Candidates for 2nd Vice President 9 other Candidates for Council			
Vote for Committee on Research (3 year term)			
A. B. Algren, Minneapolis, Minn.	1536	7	1543
M. C. Giannini, New York, N. Y.	1500	7	1507
F. W. Hutchinson, Berkeley, Calif.	1538	7	1545
C. W. Johnson, Windsor, Ont.	1502	7	1509
W. E. Zieber, York, Pa.	1486	7	1493
Scattering Votes for 7 other Candidates			
Vote for Amendments to Constitution			
Legal Ballots: For	1530	5	1535
Legal Ballots: Against	17	1	18

Board of Tellers
C. S. Koehler, *Chairman*
P. B. Gordon
H. S. Johnson

The Council for 1948 held its organization meeting on February 5, with Pres. G. L. Tuve presiding. Approval was given to the committee appointments announced by President Tuve and the appointments of the Secretary, Technical Secretary, and Assistant to the President were confirmed for the coming year. Depositories for funds were selected and the appointment of a Certified Public Accountant was approved. The Council discussed a resolution from the Chapter Delegates Committee for a By-Law amendment which will be sent out to all members in advance of the Semi-Annual Meeting.

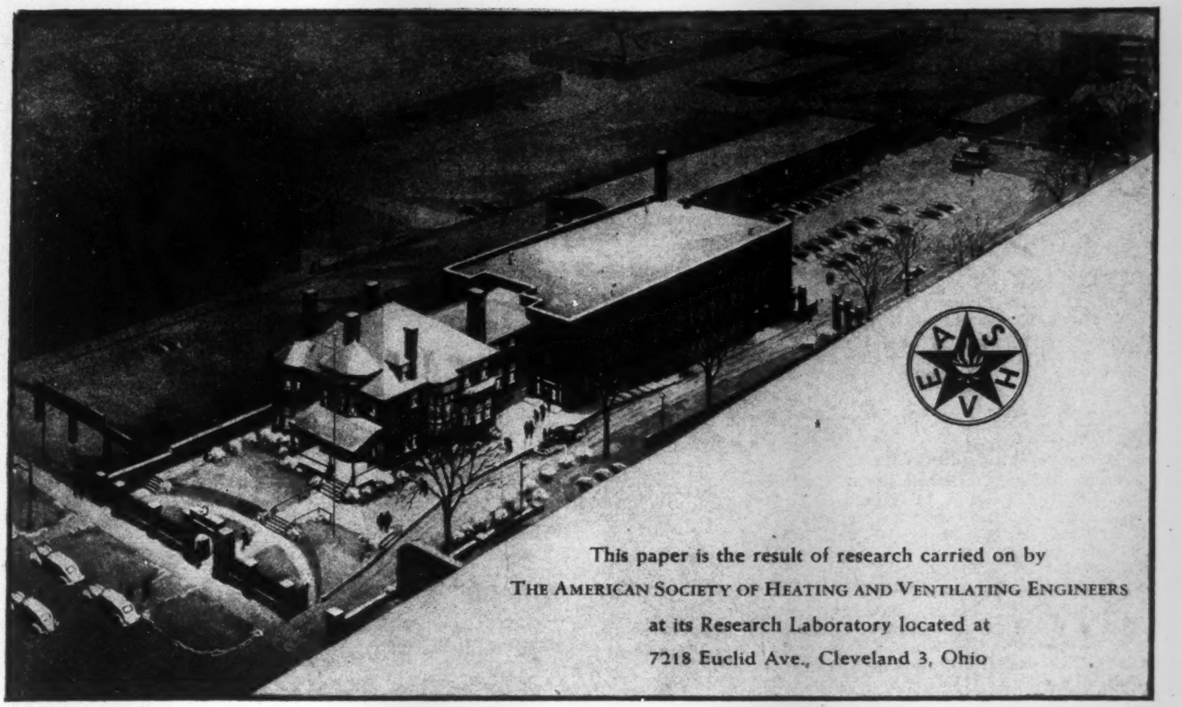
Chapter Delegates' Meetings

During the Annual Meeting, three sessions of the Chapter Delegates Committee were held, the first on Monday afternoon, February 2, the second on Tuesday, February 3, and the third on February 4. At the first session seven members and an alternate were selected to serve on the Nominating Committee. A petition was submitted for an amendment to the Constitution which would permit the chairman of the Chapter Delegates Committee to serve as an ex-officio member of the Council.

The Chapter Delegates elected C. Rollins Gardner, Dallas, Tex., as chairman, and John Everetts, Jr., San Francisco, Calif., as secretary. A report was received from the Special Committee on a Uniform Set of By-Laws for Chapters and there was some discussion of the question regarding time of election of Chapter officers.

At the meetings all of the 39 Chapters were represented.

(The detailed Proceedings of the 54th Annual Meeting will appear in the April Journal Section.)



This paper is the result of research carried on by
THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
at its Research Laboratory located at
7218 Euclid Ave., Cleveland 3, Ohio

L. P. Saunders, ***Chairman***
Lockport, N. Y.

T. H. Urdahl
Vice Chairman
Washington, D. C.

L. N. Hunter
Executive Committee
Johnstown, Pa.

Committee on Research

ASHVE Research Laboratory, 7218 Euclid Ave., Cleveland 3, Ohio
(Tel.: EXpress 6161)

L. P. SAUNDERS, *Chairman*

T. H. URDAHL, *Vice-Chairman*   A. C. FIELDNER, *Ex-Officio*

CYRIL TASKER, *Director of Research*

Executive Committee: L. P. SAUNDERS, *Chairman;* T. H. URDAHL, *Vice-Chairman;* R. M. CONNER, L. N. HUNTER, W. E. ZIEBER.

Three Years: R. C. CROSS, M. K. FAHNESTOCK, JOHN JAMES, F. J. KURTH, T. H. URDAHL.

Two Years: L. N. HUNTER, C. O. MACKEY, R. D. MADISON, L. G. MILLER, L. P. SAUNDERS.

One Year: R. M. CONNER, JOHN A. GOFF, F. W. HUTCHINSON, R. K. THULMAN, W. E. ZIEBER.

W. E. Zieber
Executive Committee
York, Pa.

R. M. Conner
Executive Committee
Cleveland, Ohio

Technical Advisory Committees for 1947

Air Cleaning: R. S. Dill, *Chairman;* R. C. Cross*, O. C. Eliason, R. S. Farr, C. D. Graham, A. B. Hubbard, R. E. Hunsaker, D. L. Hunzicker, J. W. May, R. H. Mills, G. W. Penney, R. S. Poole, R. P. Warren, W. N. Witheridge, R. D. Wood.

Air Distribution and Air Friction: Ernest Szekely, *Chairman;* N. E. Berry, S. H. Downs, W. H. Hoppmann, II, F. J. Kurth*, J. N. Livermore, R. D. Madison*, G. E. McElroy, L. G. Miller*, D. W. Nelson, G. B. Priester, C. A. Thorp, T. H. Troller, J. H. Van Alsburg.

Air Sterilization: W. F. Wells, *Chairman;* W. T. Anderson, Jr., L. J. Buttolph, C. W. Flood, Jr., Leonard Greenburg, M.D., B. H. Jennings, F. W. Hutchinson*, J. A. Reyniers, Mildred Wells, M.D., C.-E. A. Winslow.

Cooling Load: W. E. Zieber*, *Chairman;* C. M. Ashley, *Vice-Chairman;* R. D. Blum, W. F. Friend, R. H. Heilman, H. W. Heisterkamp, R. C. Jordan, C. F. Kayan, J. N. Livermore, R. H. Lock, C. O. Mackey*, C. H. Randolph, J. P. Stewart.

Corrosion: L. F. Collins, *Chairman;* R. M. Conner*, A. S. Gates, Jr., A. E. Griffin, E. W. Guernsey, R. L. Hallett, P. G. Kayser, H. A. Pray, F. N. Speller.

Fuels: E. T. Selig, Jr., *Chairman;* P. R. Achenbach, J. F. Barkley, R. M. Conner*, W. A. Danielson, R. B. Engdahl, L. N. Hunter*, R. C. Johnson, S. Konzo, J. W. Miller, W. M. Myler, Jr., H. J. Rose, T. H. Smoot, R. K. Thulman*, E. C. Webb.

Glass: R. A. Miller, *Chairman;* A. B. Algren, F. L. Bishop, Jr., J. E. Frazier, J. S. Herbert, E. H. Hobbie, L. K. Jones, C. O. Mackey*, F. Preston, W. C. Randall, Vic Sanders, H. B. Vincent, G. B. Watkins.

Heating Load: T. F. Rockwell, *Chairman;* C. M. Ashley, R. A. Biggs, A. I. Brown, R. C. Cross*, R. S. Dill, W. S. Harris, J. M. Hartman, S. I. Rottmayer, M. W. Shears, G. H. Tuttle.

Industrial Ventilation: W. N. Witheridge, *Chairman;* A. D. Brandt, W. B. Harris, W. C. L. Hemeon, D. E. Humphrey, J. M. Kane, M. G. Kershaw, L. L. Lewis, L. G. Miller*, H. A. Mosher, R. S. Poole, B. F. Postman, B. R. Small, R. P. Warren, H. E. Ziel.

Insulation: E. R. Queer, *Chairman;* R. E. Backstrom, C. B. Bradley, H. E. Lewis, L. E. Pasek, H. E. Robinson, Vic Sanders, T. D. Stafford, R. K. Thulman*, T. T. Tucker, P. M. Woodworth.

Panel Heating and Cooling: *Steering Committee:* G. D. Winans, *Chairman;* A. B. Algren, R. L. Byers, P. B. Gordon, L. N. Hunter*, John James*, J. S. Locke, H. F. Randolph.

Group A: L. N. Hunter*, *Chairman;* P. B. Gordon, *Vice-Chairman;* A. B. Algren, R. A. Biggs, Wharton Clay, R. S. Dill, H. L. Flodin, F. E. Giesecke, W. S. Harris, C. F. Kayan, G. D. Lain, R. S. Leigh, C. W. Meininger, D. L. Mills, C. W. Nessell, P. S. Park, S. I. Rottmayer, S. M. Van Kirk, L. H. Yeager.

Group B: John James*, *Chairman;* H. F. Randolph, *Vice-Chairman;* C. M. Ashley, J. T. Bergen, C. F. Boester, Linn Helander, A. L. Jaros, Jr., H. A. Lockhart, C. O. Mackey*, R. A. Miller, G. W. Penney, G. G. Sward, J. M. van Nieukerken.

Group D: J. S. Locke, *Chairman;* A. B. Algren, H. W. Alyea, S. D. Browne, R. L. Campbell, C. M. Garner, P. B. Gordon, W. J. Hajek, A. J. Keating, W. H. Kliever, H. T. Kucera, P. F. Neess, R. S. Penn, J. K. M. Pryke, E. J. Ritchie, C. W. Signor, N. D. Skinner, A. S. Widdowfield.

Physiological Research: C.-E. A. Winslow, *Chairman;* Thomas Bedford, M.D., A. R. Behnke, M.D., A. C. Burton, E. F. DuBois, M.D., A. P. Gagge, F. W. Hutchinson*, R. W. Keeton, M.D., D. H. K. Lee, M.D., André Missenard, Charles Sheard.

Sensations of Comfort: C. P. Yaglou, *Chairman;* R. S. Arnold, A. R. Behnke, M.D., Thomas Chester, F. G. Ewens, M. K. Fahnestock*, J. D. Hardy, M.D., F. C. McIntosh, A. B. Newton, K. E. Robinson.

Sorbents: John Everetts, Jr., *Chairman;* F. C. Dehler, John A. Goff*, C. H. B. Hotchkiss, E. R. McLaughlin, J. C. Patterson, G. L. Simpson, F. J. Swaney.

Sound Control: T. A. Walters, *Chairman;* C. M. Ashley, P. H. Geiger, W. H. Hoppmann, II, G. C. Kerr, R. D. Madison*, J. S. Parkinson, A. G. Sutcliffe, T. H. Troller.

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*Member of Committee on Research.

INSTITUTIONS COOPERATING WITH THE COMMITTEE ON RESEARCH

Agricultural and Mechanical College of Texas, College Station, Tex.: The Effect of Secondary Turbulence on the Friction in a Flowing Stream of Water.

Case Institute of Technology, Cleveland, Ohio: Air Distribution Project; Heat Transfer of Evaporating Refrigerants.

Kansas State College, Manhattan, Kans.: Projection of Heated and Cooled Air Streams; Experimental Studies of Radiant Heating and Cooling.

University of California, Berkeley, Calif.: Cooling Tower Design and Performance.

University of Illinois—College of Medicine, Chicago, Ill.: Physiological Adjustments of Human Beings to Rapid Changes in Environment.

University of Minnesota, Minneapolis, Minn.: Statistical Analysis of Variables Entering into Sensory Reactions to Summer Air Conditioning.

RESEARCH PAPERS—1947

1. Comfort Reactions of 275 Workers During Occupancy of Air Conditioned Offices, by Frank B. Rowley, Richard C. Jordan, and Warren E. Snyder (Minneapolis) (June 1947, JOURNAL SECTION).
2. Physiological Adjustments of Human Beings to Sudden Change in Environment, by Nathaniel Glickman, Tohru Inouye, Stanley E. Telser, M.D., Robert W. Keeton, M.D., Ford K. Hick, M.D. (Chicago) and Maurice K. Fahnestock (Urbana, Ill.) (July 1947, JOURNAL SECTION).
3. Heat Transfer by Forced Convection Along a Smooth Flat Surface, by G. V. Parmelee and R. G. Huebscher (Cleveland) (August 1947, JOURNAL SECTION).
4. The Challenge of the ASHVE Research Program, by Cyril Tasker (Cleveland) (August 1947, JOURNAL SECTION).
5. Thermal Properties of Building Materials, by H. B. Nottage (Cleveland) (September 1947, JOURNAL SECTION).
6. The Downward Projection of Heated Air, by Linn Helander and C. V. Jakowatz (Manhattan, Kansas).
7. The Discharge of Air from a Long Slot, by Alfred Koestel and G. L. Tuve (Cleveland) (January 1948, JOURNAL SECTION).
8. Friction Equivalents for Round, Square and Rectangular Ducts, by R. G. Huebscher (Cleveland) (December 1947, JOURNAL SECTION).
9. Measurements of Solar Heat Transmission Through Flat Glass, by G. V. Parmelee, W. W. Aubele, and R. G. Huebscher (Cleveland) (January 1948, JOURNAL SECTION).

PARTICIPATING IN 1947 RESEARCH PROGRAM

Airtemp Division of Chrysler Corp.
*Aluminum Company of America
*American Air Filter Co., Inc.
American Blower Corp.
American Radiator & Standard Sanitary Corp.
*American 3 Way-Luxfer Prism Co.
*American Window Glass Co.
*Anemostat Corporation of America
Automatic Burner Corp.
Avery Engineering Co.
Barber-Colman Co.
Barnes & Jones, Inc.
Bastian-Morley Co., Inc.
Bethlehem Steel Co. (Subsidiary Companies of)
*Blue Ridge Glass Corp.
Buffalo Forge Co.
Carnegie-Illinois Steel Corp.
**Carrier Corp.
Clarage Fan Co.
Columbus Heating & Ventilating Co.
Crane Co.
Detroit Stamping Co.
*Dollinger Corp.
Duquesne Light Co.
*Farr Co.
Forslund Pump & Machinery Corp.
Frick Co.
G & O Manufacturing Co.
Hoffman Specialty Co.
Ilg Electric Ventilating Co.
*The Institute of Boiler & Radiator Manufacturers
Keeney Publishing Co.
Kewanee Boiler Corp.
Kinetic Chemicals, Inc.
Kramer Trenton Co.
*Libbey-Owens-Ford Glass Co.
The R. C. Mahon Co.
The Marley Co., Inc.
Everett N. McDonnell Foundation
Mellish and Murray Co.
*Metal Window Institute
*Minneapolis-Honeywell Regulator Co.
*Mississippi Glass Co.
The Nash Engineering Co.
John J. Nesbitt, Inc.
*Oil-Heat Institute of America, Inc.
*Owens-Corning Fiberglas Corp.
*Owens-Illinois Glass Co.
*Pennsylvania Wire Glass Co.
*Pittsburgh Corning Corp.
*Pittsburgh Plate Glass Co.
*The Pyle-National Co.
Raisler Corp.
Ranco, Inc.
Mr. W. R. Rhoton
*Servel, Inc.
Spencer Thermostat Co.
Mr. DeParx Stimson
Surface Combustion Corp.
The Trane Co.
The Tremco Mfg. Co.
Viking Air Conditioning Corp.
The Webster Engineering Co.
White-Rodgers Electric Co.
L. J. Wing Mfg. Co.
*Young Radiator Co.

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*Earmarked Contributions
**General and Earmarked

1947 Annual Report of Committee on Research

By L. P. Saunders, Chairman

THE MOST significant event which occurred during 1947 was of course the dedication of the new Research Laboratory at 7218 Euclid Ave., Cleveland, Ohio, approximately 500 members and guests attending this ceremony. This event was the culmination of an objective instigated nearly 30 years ago when the original decision was reached that the Society should engage in research activities. More and more as time goes on the many desirable features of both the site and the buildings justify the careful planning of the committees in charge of the selection and purchase of this property. To date we have not been confronted with a condition for which the facilities of the building have not been suitable.

The Committee on Research wishes to thank the Council for their wholehearted support and close cooperation during the year 1947, gratefully appreciating their very fine spirit of cooperation.

Pres. B. M. Woods, in his message on Society Progress as of December 1, referred specifically to the remaining indebtedness on the Research Laboratory which is approximately $12,000. To date, almost $20,000 has been received for application against the original mortgage indebtedness of $32,000. The Committee on Research is indeed grateful for this recognition of the confidence of the membership as a whole as demonstrated in this manner.

Committee Activities

As in previous years, the Chairman and members of the Technical Advisory Committees have shared with the Committee the responsibility of planning and supervising the research program, and we wish to offer our sincere thanks to all for their very considerable support.

During the year four meetings of the Committee on Research have been held, the locale being the Cleveland Laboratory, and we wish to emphasize the excellence of the facilities for holding meetings of this nature at the Laboratory. A twofold purpose is served, one, the meeting proper, and two, the personal contacts with members of the staff which are beneficial to all concerned.

In addition to the Committee on Research, there were three meetings of the Research Executive Committee, two of these being held at the Laboratory, and 19 meetings of Technical Advisory Committees, most of which were held at the Laboratory. The total committee attendance was 250 members and 113 guests. These committees perform a very important function in the ongoing of the research program and their unstinted support is thankfully acknowledged.

Industry Support

We are still further encouraged by the cordial reception reported by C. A. McKeeman, assistant to the president, who acts in a liaison capacity between the Society and the industry. In consequence, the budget for 1948 has been increased above that for the current year.

Research Policy

The proposed revisions in the Constitution, By-Laws and Rules of the Society reiterate that the work conducted by the Research Laboratory of this Society shall be confined to a determination of the basically fundamental principles or laws underlying all matters in the science of heating, ventilating or air conditioning. The Committee on Research and the Council should continue to give serious consideration to the problems of Society codes and standards so that they may be constantly reviewed and brought up to date in the best interest of the membership and the protection of the general public.

Publication Program

Again referring to the proposed revised Constitution, By-Laws and Rules, Article B-VIII, *Section* 5 refers specifically to the duties of the Program and Papers Committee, and Article B-XII to Publications and Papers. A publication policy has been established with respect to the printing of bulletins, presentation of papers by title and in condensed form. It is believed that these changes will greatly increase the interest of the membership by keeping them more closely in touch with the activities of the Research Laboratory.

Future Plans

Again referring to President Woods' message on Society Progress as of December 1st, a budget of $96,100 has been set up for the ensuing year, this amount including the 40 percent of the members dues and such funds as have been provided by industry for a continuance of both general and specific programs. A budget of this magnitude is possible through the combined efforts of J. E. Haines' Committee on the Promotion of Research and Mr. McKeeman.

Additional activities undertaken by the Laboratory should receive very careful consideration both from a personnel and financial point of view. We are most fortunate in the quality of the personnel under Director Tasker, whose leadership is responsible for the *esprit de corps* which exists.

Specifically, we would like to emphasize the desirability of reviewing in detail the duties of the Technical Advisory Committees with particular reference to their specific activities and suggest that it may be highly desirable to appoint a member of each individual Technical Advisory Committee as the Secretary for that Committee so that a systematic follow-up of the duties under the direction of the Chairman may be made and reports submitted to the Committee on Research.

The matter of the technical data for THE GUIDE is ever before us with the responsibility of providing up-to-date technical information for those engaged in the rewriting of any specific chapter, and to this end in view of the urgency of the National Housing Program as a whole, we believe it most desirable that the heat loss values for building and insulating materials be very carefully scrutinized. Further in connection with the over-all housing problem, it has been suggested that the infiltration values in relation to modern construction methods also be further investigated.

A detailed report by the Director of Research on activities at the Laboratory and cooperative institutions and of the Technical Advisory Committees follows.

Presented at the 54th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, New York, N. Y., February 1948.

Report of the Director of Research

By Cyril Tasker

Introduction

The past year has seen the steady development of Society research toward a broad comprehensive program containing at least one or two projects of direct interest and value to each member. The major projects have been those coming under the general direction of the Technical Advisory Committee on Glass, the studies designed to lead to the development of acceptable methods for testing and rating air cleaning devices, and the programs developed by the groups comprising the Technical Advisory Committee on Panel Heating and Cooling. However, several other laboratory and cooperative research projects under way in 1947, while receiving less publicity, will, as the results become known, take their place as important parts of the overall program.

The increase in membership in the Society in recent years and the expansion of the industry have presented problems for the Committee on Research, the technical advisory committees, and the Laboratory staff which are as important as any that have arisen during the past 28 years. The ASHVE research program is becoming better known throughout the industry and among the memberships of the trade associations. The privilege afforded this year to visit the home offices of some of the organizations in the industry and to attend several trade association meetings to discuss the achievements, program, and possibilities of ASHVE research was greatly appreciated.

These meetings, the many personal contacts made by C. A. McKeeman throughout the industry, and the distribution of the booklet *A Quarter-Century-Plus of ASHVE Research* have resulted in wider industry financial participation in the program and in increasing amounts made available and earmarked for specific projects. The growing success of efforts to secure industry support has encouraged us to set a budget for 1948 approaching $100,000.

Both laboratory and office facilities at Cleveland have been improved during the past year and additional apparatus and equipment constructed or purchased as required. Our contacts with other laboratories throughout the country and abroad have grown; the number of visitors, including those from abroad, has continued to increase, as have references to our work in home and foreign publications.

Publications

In addition to nine research papers originating in the Laboratory and cooperating institutions, all of which have been or will be published in the ASHVE JOURNAL SECTION of *Heating, Piping & Air Conditioning*, three research bulletins have been completed during 1947. Two have been printed; the third is now on the press. These comprise the first tangible results of the publication policy recommended by a special Council committee in October, 1946. By means of these bulletins, complete reports of certain phases of our work will be made available to the membership and the industry and will find a place in the libraries of engineering schools throughout the country.

Staff

The quality and widening experience rather than the numerical size of its staff is the prime asset of any research organization. We are fortunate in having a well-knit team which, while growing slowly numerically, is growing rapidly in accumulated experience. J. W. Maier joined us in March to work on the projects under the Technical Advisory Committee on Air Cleaning; D. W. Locklin joined the staff in October when he was graduated from the University of Illinois.

C. M. Humphreys, as Senior Engineer, while sharing some of the administrative duties with the writer, has brought to many of the current projects a well-rounded experience in design and construction. We now have a scientific and technical staff of 10 persons and a total staff of 16. Plans are in hand to define the conditions under which Laboratory staff members may carry on graduate studies at Case Institute of Technology.

Guide

Active liaison has been maintained with the Guide Publication Committee, and staff members have assisted in the review and revision of certain Guide chapters. The interval which elapses between the first publication of the results of research and their appearance in the HEATING, VENTILATING, AIR CONDITIONING GUIDE gives an opportunity for thorough study and criticism of all new data before they become part of the handbook of the profession.

Studies at the Laboratory and at Cooperating Institutions

Following the plan previously used, this report will only summarize the principal activities at the Laboratory and the cooperating institutions and the work of the Technical Advisory Committees. The staff will gladly supply fuller details on request. During the latter part of the year copies of progress reports made to the Committee on Research have been distributed to all chapter officers through the medium of the Chapter Relations Committee.

Air Distribution and Air Friction

Studies dealing with problems in air distribution have long held an important place in the Society's research program. Over the past 20 years almost 30 papers resulting from ASHVE research in this field have appeared in the TRANSACTIONS: three more are being presented at the 54th Annual Meeting covering recent studies made under the Technical Advisory Committee on Air Distribution and Air Friction (Ernest Szekely, *Chairman*).

Friction Equivalents: An investigation of the friction equivalents for round, square, and rectangular ducts was completed at the Laboratory (see Fig. 1). The results showed that for most practical purposes rectangular ducts having aspect ratios not exceeding 8:1 will have the same static friction loss for equal lengths and mean velocities of flow as a circular duct of the same hydraulic diameter. A new table of circular equivalents for rectangular ducts was developed; it is based on these studies and the ASHVE (Wright) Friction Chart.

We plan to extend these studies to cover both through-flow and branch off-take fittings. Available data on typical fittings are meager and contradictory, and dependable data should prove of real value to the industry.

Cooperative Studies: Cooperative work at Case Institute of Technology is reported in the paper, The Discharge of Air

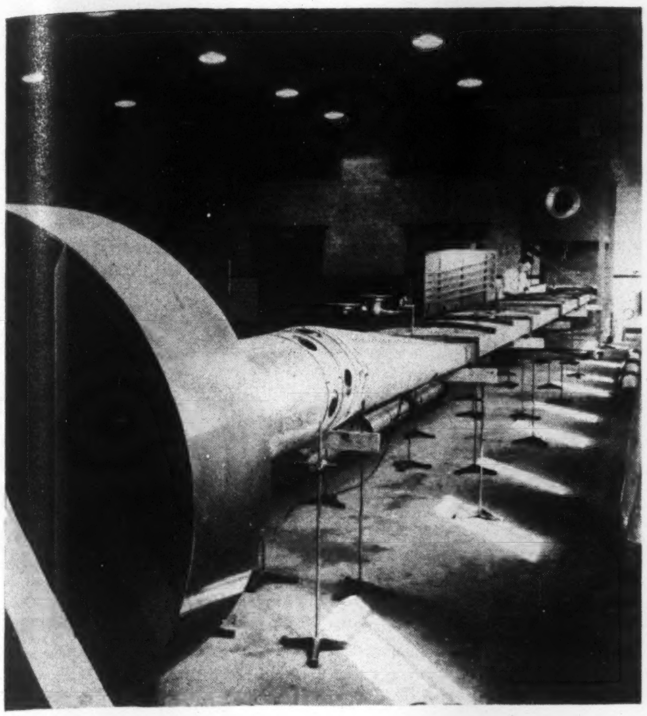

Fig. 1—Air duct friction set-up in upper Laboratory showing metering box and nozzle

This large room, 50 ft x 90 ft x 18 ft, is ideal for fluid flow and air distribution studies. The equipment is being used to determine friction variations in equivalent round, square, and rectangular ducts

from a Long Slot, by Alfred Koestel and G. L. Tuve. An experimental study was made of the relations between supply-duct area, slot area, discharge quantity and velocity in magnitude and direction, and the static and dynamic pressures in the duct. It was shown that for practical purposes the slot discharge quantity could be determined for any given duct static pressure in terms of an experimentally established function of the ratio of slot to duct areas. As part of an assignment to find the behavior of an air stream in free space, the studies at Case Institute over the past few years have covered plain openings of every type and of almost all shapes.

The downward projection of heated air has been under investigation at Kansas State College, and a paper summarizing the results obtained with initial jet temperatures up to 180 F, initial velocities up to 1800 fpm and stream diameters of 5¾ and 6½ in., will be presented at the 54th Annual Meeting by Linn Helander and C. V. Jakowatz. Having developed an idealized analysis for predicting the downblow distance and diameter of a projected stream, the authors have established constants for the equations experimentally. The test equipment and experimental techniques developed will enable these studies to be extended to cover other conditions.

Ventilation Jets: As an important part of the contribution to be made in this field by the Research Laboratory, H. B. Nottage has compiled a comprehensive literature survey on problems concerned with the behavior of ventilation jets; it is now being prepared for publication. Equipment and instruments are being assembled to enable experimental studies to be made at Case Institute on horizontally projected jets.

Members of the Technical Advisory Committee cooperated in the revision of the Chapter on Air Distribution for The Guide 1948 and in clarifying definitions and terminology in this field.

Barometric Dampers: Experimental studies (see Fig. 2) on four typical dampers were completed in the latter part of the year and the results compiled for study by the Technical Advisory Committee on Fuels (E. T. Selig, *Chairman*). Though large numbers of these devices are used on automatic fuel-burning equipment, there is little information available on their characteristics and performance. A better understanding of their functions might lead to improved performance in the control of combustion.

Industrial Ventilation: Industrial ventilation is of increasing importance and interest to members of the Society and, through the Technical Advisory Committee on Industrial Ventilation, set up during the year under the chairmanship of W. N. Witheridge, they should be kept closely in touch with developments in this field. As part of its activities, the committee plans to correlate the work of other groups in the field of industrial hygiene and ventilation and interpret this work for the ventilating engineer.

The collection of state laws concerning industrial ventilation, loaned by the Research Laboratory in 1946 to the Michigan Department of Health (see 1946 Report of Committee on Research), was expanded by K. J. Caplan who is reporting on his analysis at the 54th Annual Meeting.

Heat Flow and Heat Transfer

The studies under four Technical Advisory Committees (Cooling Load, Glass, Heating Load, and Insulation) are covered under this section. Steady progress has been made throughout the year; two research papers were presented at the Semi-Annual Meeting; another will be presented at the Annual Meeting.

Film Coefficients: A research bulletin (Vol. 53, No. 3) entitled Forced Convection Coefficients—Smooth Surfaces is on the press. It covers in some detail the studies on heat transfer for turbulent and laminar boundary layer flow. It also reviews published work in this field and summarizes the results. A research paper covering part of this work was presented at the Semi-Annual Meeting.

Test work is under way to determine the combined effects of natural convection and low velocity air movement. Changes made in the wind tunnel permit the measurement of velocities as low as 30 fpm. The studies are being made as a part-time graduate thesis project.

Solar Radiation Transmission: The equipment designed, constructed, and erected at the Laboratory for the study of solar radiation transmission through glass is unique and has proved of great interest not only to the glass and allied industries but to almost every visitor to the Laboratory during the past two years. Experimental work commenced in the early part of the winter of 1946-47 and has continued steadily since

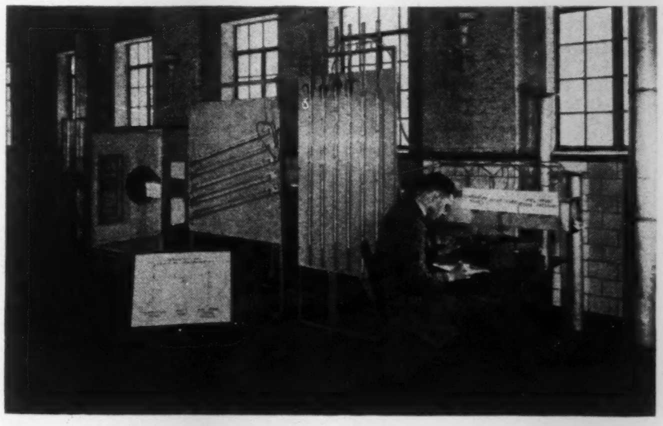

Fig. 2—Equipment for study of performance of barometric draft control dampers

that time. During part of last summer the equipment was operated for periods up to 12 hours each day.

During the year we have collected data on six types of single glass, and on three combinations of double glass. Included among the samples investigated were several types of heat-absorbing glass. The data are being analyzed to account for the heat exchange between the glass and the indoor and outdoor surroundings. A paper to be presented at the Annual Meeting covers preliminary tests made on four types of single glass.

During the year this project has received the active financial and technical support of the glass and window industry and of the air conditioning industry. So far as we can tell, no work similar to this is going on in any other research organization in this country or abroad.

A comprehensive research bulletin entitled Heat Transmission Through Glass, Vol. 53, No. 1, is now on the press. It is in two parts; Part I entitled Overall Coefficients of Heat Transmission of Windows and Glass-Block Panels, deals with hot box tests under laboratory controlled conditions, and Part II, entitled Solar Heat Transmission by Windows and Glass Block Panels, covers all known experimental work up to 1941 on solar radiation transmission through glass. It is believed that this bulletin will prove to be a valuable contribution to the literature on this subject.

Periodic Heat Flow: ASHVE Research Bulletin, Vol. 53, No. 2, summarizes the results of a comprehensive search of the literature for ready-reference data on thermal conductivity, density and unit heat capacity of common building materials. The bulletin, prepared by Mr. Nottage, contains the material mentioned in last year's report under the title Volumetric Specific Heat of Building Materials. By means of charts which are included in the bulletin, estimates may be made of thermal conductivity, thermal diffusivity, or the product (thermal conductivity) x (density) x (unit heat capacity). A short paper giving the highlights of this bulletin was presented by Mr. Nottage at the Semi-Annual Meeting. The data are of special value in calculations of periodic heat flow in the determination of cooling loads. The studies were made under the Technical Advisory Committee on Cooling Load (W. E. Zieber, *Chairman*).

Following discussions with Prof. H. A. Johnson, University of California, a paper is being presented at the 54th Annual Meeting entitled Periodic Heat Transfer at the Inner Surface of a Homogeneous Wall. The committee feels that the work of Professor Johnson is an important step toward the development of tables for determining the instantaneous rates of heat flow through various solid structures. It is anticipated that these calculations can be amplified and extended for use in air conditioning applications.

Data on sol-air temperatures previously published for New York City and Lincoln, Nebr., show the effect of an industrial *vs.* a rural atmosphere. Plans are in hand to extend these data to include values for a humid-area atmosphere. A subcommittee on lights and appliances has agreed upon tests for various appliances and lighting equipment, and members of the subcommittee are carrying on field work to obtain more dependable data for this part of the cooling load.

Insulation: Twenty laboratories, including one foreign laboratory, are participating in the program to obtain more accurate and dependable values of the thermal conductivity of building materials. All have been supplied with samples of corkboard; tests have been completed by 11 laboratories on 13 samples. These samples have been sent to the National Bureau of Standards where check tests are now under way. The Technical Advisory Committee on Insulation is cooperating with a committee of *ASRE* in this program.

Heat Transfer Coefficients of Evaporating Refrigerants: The investigation of coefficients of heat transfer for Freon-12 evaporating in horizontal tubes has continued during the past year with emphasis on the collection of data on the effects of several variables; specifically, data have been obtained to demonstrate the effects of the following variables: ratio of tube length to diameter, refrigerant flow and refrigerant quality, evaporator load, and temperature difference from tube to refrigerant. The range covered by each variable has been extended beyond that previously available. At the present time data are being collected to show the effect of turbulence promoters on the heat transfer coefficient.

No satisfactory methods of correlating the data have yet been devised, but it is hoped that some of the recent theoretical studies of evaporation may provide a basis for presenting the results in a logical manner.

Physiological Research

Environment and Comfort: The paper by F. B. Rowley, R. C. Jordan, and W. E. Snyder entitled Comfort Reactions of 275 Workers During Occupancy of Air Conditioned Offices, presented at the Semi-Annual Meeting, reported the results of a study of the general reactions of employees in an air conditioned office building during working hours in the summertime. The maximum number of persons indicating comfort occurred at a dry bulb temperature of 74 F, and variations of relative humidity between 35 and 60 percent caused no appreciable change in the feeling of comfort. This paper, together with two others presented at the same meeting, raised questions as to whether or not the Effective Temperature Index and all comfort charts based on it stood in need of revision, because they over-estimated the thermal effect of humidity in temperatures below 80 F for persons at rest or in situations in which there is no active sweating. One of these papers, prepared by the Technical Advisory Committee on Sensations of Comfort (C. P. Yaglou, *Chairman*), suggested the use of mean skin temperature as the basis for correcting the index for humidity and radiation. All the evidence points to a real need for additional research to clarify some of the points under discussion.

Shock Effect: The results of studies to investigate the physiological adjustments of human beings to sudden change in environment were presented in a paper by Nathaniel Glickman, Dr. R. W. Keeton and their associates, at the Semi-Annual Meeting. A large number of tests with healthy young adult males showed that in general the physiological adjustments made on passing from a comfortable to a hot moist environment and vice versa occurred rapidly and placed little strain on the cardiovascular system. The studies reported in this paper were made in the summer months of 1946. Some of the subjects were studied under comparable experimental conditions during the winter months of 1946-1947. No very significant differences were observed between the physiological adjustments made during the summer and the winter periods. Certain tests were also made during the past summer using 12 subjects, ranging in age from 25 to 72 years, with cardiovascular impairment. For all these subjects the physiological adjustments to sudden changes of environment appeared to be made as easily and with as little strain on the cardiovascular system as with healthy young men.

All Society research dealing with physiological reactions is under the direction of the Technical Advisory Committee on Physiological Research (Dr. C.-E. A. Winslow, *Chairman*).

Panel Heating and Cooling

There has been considerable activity in this field during 1947. At the 53rd Annual Meeting the Committee on Research approved the calling of a conference of organizations interested in this field. This conference was held at the Laboratory in March and was attended by over 100 persons. It was recommended that steps be taken to form a technical advisory committee and develop a comprehensive research program. A steering committee was formed in June under the chairman-

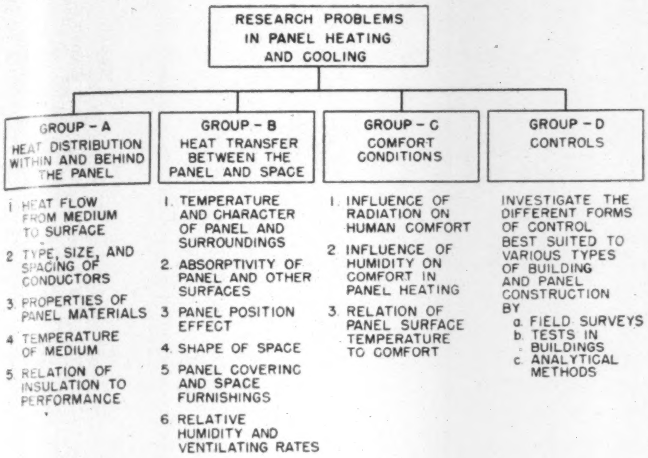
RESEARCH PROBLEMS IN PANEL HEATING AND COOLING
GROUP - A
HEAT DISTRIBUTION WITHIN AND BEHIND THE PANEL
1. HEAT FLOW FROM MEDIUM TO SURFACE
2. TYPE, SIZE, AND SPACING OF CONDUCTORS
3. PROPERTIES OF PANEL MATERIALS
4. TEMPERATURE OF MEDIUM
5. RELATION OF INSULATION TO PERFORMANCE
GROUP - B
HEAT TRANSFER BETWEEN THE PANEL AND SPACE
1. TEMPERATURE AND CHARACTER OF PANEL AND SURROUNDINGS
2. ABSORPTIVITY OF PANEL AND OTHER SURFACES
3. PANEL POSITION EFFECT
4. SHAPE OF SPACE
5. PANEL COVERING AND SPACE FURNISHINGS
6. RELATIVE HUMIDITY AND VENTILATING RATES
GROUP - C
COMFORT CONDITIONS
1. INFLUENCE OF RADIATION ON HUMAN COMFORT
2. INFLUENCE OF HUMIDITY ON COMFORT IN PANEL HEATING
3. RELATION OF PANEL SURFACE TEMPERATURE TO COMFORT
GROUP - D
CONTROLS
INVESTIGATE THE DIFFERENT FORMS OF CONTROL BEST SUITED TO VARIOUS TYPES OF BUILDING AND PANEL CONSTRUCTION BY
a. FIELD SURVEYS
b. TESTS IN BUILDINGS
c. ANALYTICAL METHODS

Fig. 3—Research problems in panel heating and cooling

ship of G. D. Winans and at its first meeting broke down the overall program into four main divisions as follows:

A. Heat Distribution Within and Behind the Panel
B. Heat Transfer Between the Panel and the Space
C. Comfort Conditions
D. Controls

The chief variables under each division are shown in Fig. 3.

The Steering Committee met again in August and set up the personnel of the groups to handle Parts A, B, and D. Group A under the chairmanship of L. N. Hunter met at the Laboratory on November 5 (see Fig. 4) and approved the general plans for experimental and analytical studies. This program was approved by the Committee on Research and work commenced immediately. At the end of the year all the equipment and materials had either been delivered or were on order and satisfactory progress had been made on the preliminary parts of the program.

Group B met at the Laboratory under the chairmanship of John W. James on December 1 and also adopted a research program which will consist both of experimental and analytical studies and will call for the building at the Research Laboratory of at least one test room in which the temperatures of all enclosing surfaces can be controlled over a fairly wide range.

Group D met in Chicago on December 17 under the chairmanship of J. S. Locke and agreed to undertake a study to determine what controls are necessary for comfort regulation of panel heating and cooling systems. They recommended that the studies cover field surveys, tests in various types of buildings, and also analytical research.

Steps are being taken to put the programs of Groups B and D on an active basis as rapidly as personnel and funds permit. Close cooperation is being maintained with all organizations known to be interested in this field of activity, both in this country and abroad.

Steady progress is being made in a cooperative research project at Kansas State College, the purpose of which is to investigate the relationship between radiant heating and cooling and human comfort and well-being.

The panel heating and cooling research program is attracting a great deal of interest and active support has been promised by several organizations in the industry and by trade groups, one of which, the *Institute of Boiler and Radiator Manufacturers*, has already assisted financially in these studies.

Miscellaneous

Air Cleaning: Active work on a program designed to develop sound and acceptable codes for the testing and rating of air cleaning devices has been under way since March with the financial and technical support of both filter manufacturers and users. Mr. Maier's visits, both to filter manufacturers and large industrial users, served to impress on us not only the complexity of the problem, but the urgent need for studies of the type planned by the Technical Advisory Committee on Air Cleaning (R. S. Dill, *Chairman*). Following a program approved at a Committee meeting in August, which basically calls for the investigation of the performance of air cleaning devices with individual dusts of known particle size, test equipment, shown diagrammatically in Fig. 5, was constructed and set up at the Research Laboratory. Following calibration of the test equipment, preliminary tests have been under way

Fig. 4—TAC on panel heating and cooling—Group A meeting *(left to right) Seated:* P. S. Park, L. J. LaTart, R. S. Dill, R. A. Biggs, G. D. Lain, Miss I. M. Jahn, G. D. Winans, L. N. Hunter. *Standing:* Cyril Tasker, P. B. Gordon, Wharton Clay, C. M. Humphreys, C. A. McKeeman, John James, G. V. Parmelee, R. G. Huebscher, S. M. Van Kirk, C. W. Nessell, H. L. Flodin, A. B. Algren, H. B. Nottage, W. S. Harris

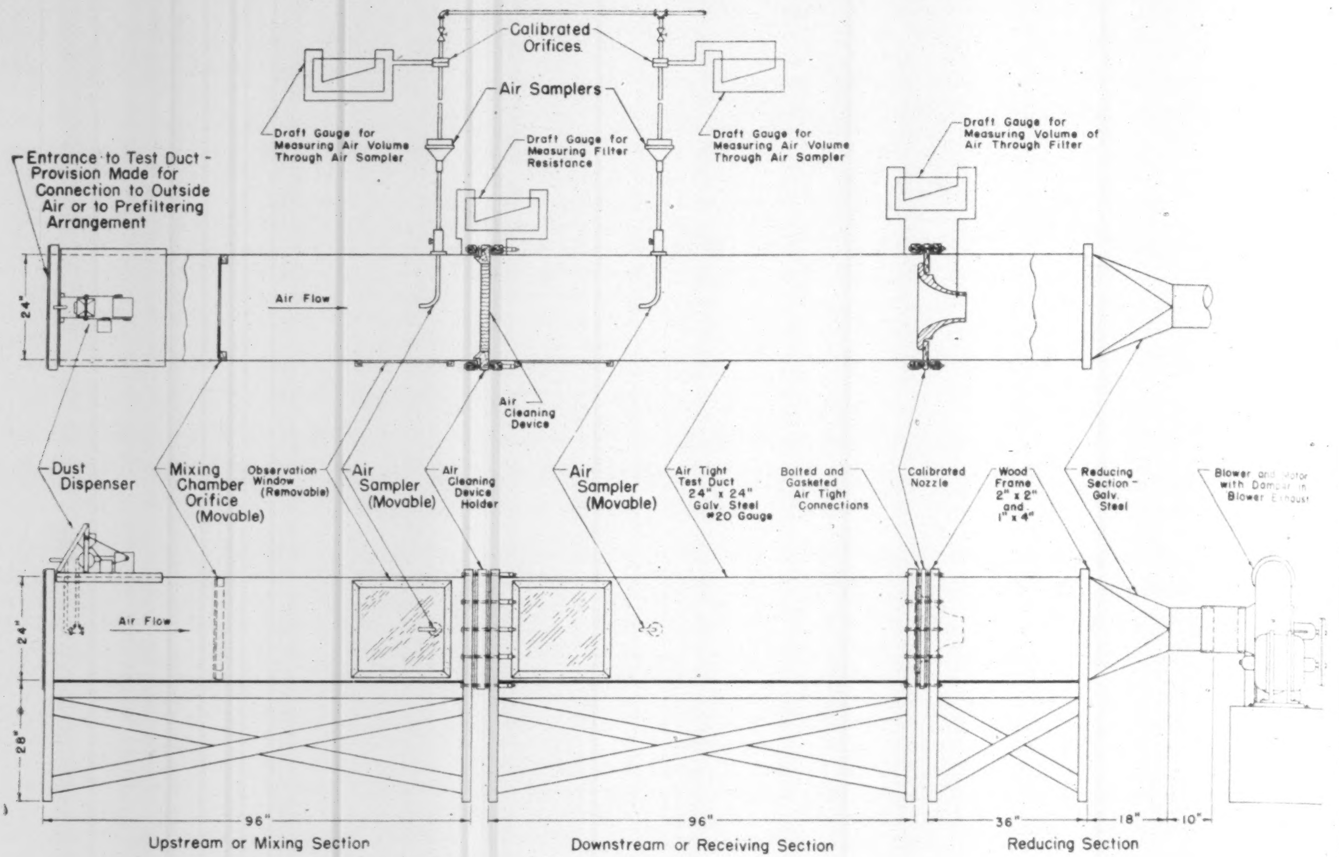
Calibrated Orifices
Air Samplers
Draft Gauge for Measuring Air Volume Through Air Sampler
Draft Gauge for Measuring Filter Resistance
Draft Gauge for Measuring Air Volume Through Air Sampler
Draft Gauge for Measuring Volume of Air Through Filter
Entrance to Test Duct - Provision Made for Connection to Outside Air or to Prefiltering Arrangement
24"
Air Flow
Air Cleaning Device
Dust Dispenser
Mixing Chamber Orifice (Movable)
Observation Window (Removable)
Air Sampler (Movable)
Air Cleaning Device Holder
Air Sampler (Movable)
Air Tight Test Duct 24" x 24" Galv. Steel #20 Gauge
Bolted and Gasketed Air Tight Connections
Calibrated Nozzle
Wood Frame 2" x 2" and 1" x 4"
Reducing Section - Galv. Steel
Blower and Motor with Damper in Blower Exhaust
Air Flow
24"
28"
96"
96"
36"
18"
10"
Upstream or Mixing Section
Downstream or Receiving Section
Reducing Section

Fig. 5—Arrangement of test equipment for studies designed to develop standard methods for testing and rating air cleaning devices

since late in November. Samples of test dusts are now being classified into definite particle sizes at the Bureau of Standards.

We were interested to learn that similar problems were facing the British filter industry and that research work was under way both at the Building Research Station and through the British Standards Institution designed to lead to acceptable standards for air cleaning devices and standard testing and rating codes. We have established and are maintaining liaison with those working in this field abroad.

Corrosion: A new chapter entitled, Water-Formed Deposits and Corrosion, will appear in THE GUIDE 1948. It has been compiled by the Technical Advisory Committee on Corrosion under the active direction of Leo F. Collins, *Chairman.*

Oil-Heat Institute

Present-day methods of producing gasoline from crude oil have markedly affected the chemical composition and physical structures of those by-products which remain for use as fuel in oil burners. This is particularly true of the lighter portions which are used in domestic units. Whereas some years ago burner fuel oils were the product of straight run distillation or thermal cracking processes, present-day fuels may contain or consist entirely of products from catalytic cracking plants. Experience has shown that such fuels have much different burning properties than fuels from a straight run distillation process although both may possess physical properties that place them in the same classification.

Therefore, a means of differentiating these oils has been sought so as to be able to supply fuel of the proper characteristics to the thousands of oil burners now in use. One of several methods that have been suggested is to burn the fuel in an apparatus that closely simulates standard practice, to measure its combustion characteristics in a suitable way, and by comparison with the burning characteristics of other fuels establish a rating for the fuel. Such a unit has been constructed according to the specifications of the *Oil-Heat Institute of America* and has been designated a Combustion Reference Test Unit.

The Committee on Research was asked by the Engineering Committee of the *Oil-Heat Institute of America* to undertake a preliminary investigation *to determine whether the unit developed accomplished the objectives of differentiating between the performance of two or more reference oils.* The Committee on Research agreed to the proposal and an investigation was carried out in December in Stamford, Conn., where the unit is at present located. G. V. Parmelee was in charge of the work and was assisted by D. W. Locklin. The Laboratory has welcomed this opportunity to cooperate with an important section of the heating industry in fundamental work of this type.

General

In addition to visiting several chapters, the writer spoke on the research program before the *National Association of Power Engineers* in Boston in August, the *Institute of Boiler and Radiator Manufacturers* in October, and the *Steel Boiler Institute* in November. C. M. Humphreys reviewed the basis of the ASHVE Effective Temperature Index and Comfort Charts at a symposium on Humidity and Comfort held at Pennsylvania State College in September.

Acknowledgments

The members of the Research Laboratory staff are grateful for the encouragement and support which they have received all during the year from the chairman and members of the Committee on Research and the members of the various Technical Advisory Committees. The support given by the officers of the Society, the Council, and the membership at large has encouraged us in the planning of a still more comprehensive program for 1948 so that Society research can assume its share of the overall research activities of the country.

JOURNAL SECTIO

A Heat Pump in an Office Building

By J. Donald Kroeker* and Ray C. Chewning**, Portland, Ore.

SUMMARY — A description of the largest heat pump installation in the U.S. Year 'round air conditioning is effected by automatic switch-over from heating and cooling as required. Special features include heat recovery from ventilation exhaust air and heating of ventilation air with waste cooling water resulting in a reduction of normal heat requirements by one third.

Water at two different temperatures is supplied by wells of different depth. No provision is made for auxiliary heating. Circulated air is the heating or cooling medium arranged to permit change of partitions without effect on distribution of air

The first non-utility office building in this country to use the heat pump, the Equitable Building, Portland, Ore., completed a few months ago, contains some unusual features.

Comprised of 12 rental office stories, basement, and two penthouse levels, the building rises 200 ft above the street; is 200 x 100 ft at the street level and 62 x 200 ft at the third floor and above; has a floor space of 212,000 sq ft, and a volume of 2,275,000 cu ft; is the first all-aluminum-clad building in the country; and incorporates some unusual architectural features, such as fixed, double glazed, column-to-column windows flush with the building faces throughout, neither horizontal nor vertical exterior reveals, and utmost flexibility of repartitioning without affecting electrical and mechanical factors.

Heat Pump Based on Economic Feasibility

The building is also the first completely air conditioned building in the Pacific Northwest. Air conditioning was a basic concept in design of the building. Since air conditioning required cooling capacity greater than design heating capacity and, since relatively low electrical costs indicated economic feasibility, design included the heat pump for both cooling and heating.

A graphic analysis of net heating load and cooling load, after considering diversity due to shading, is shown in Fig. 1. The heating curves shown as *maximum* indicate values prior to taking credit for lights, other internal mechanical loads, variable sun effect, and occupants. The cooling curves shown as *maximum* are for conditions of high outside dew points, widely variable within the cooling season.

A recapitulation of design loads is shown in Table 1. Summer de-

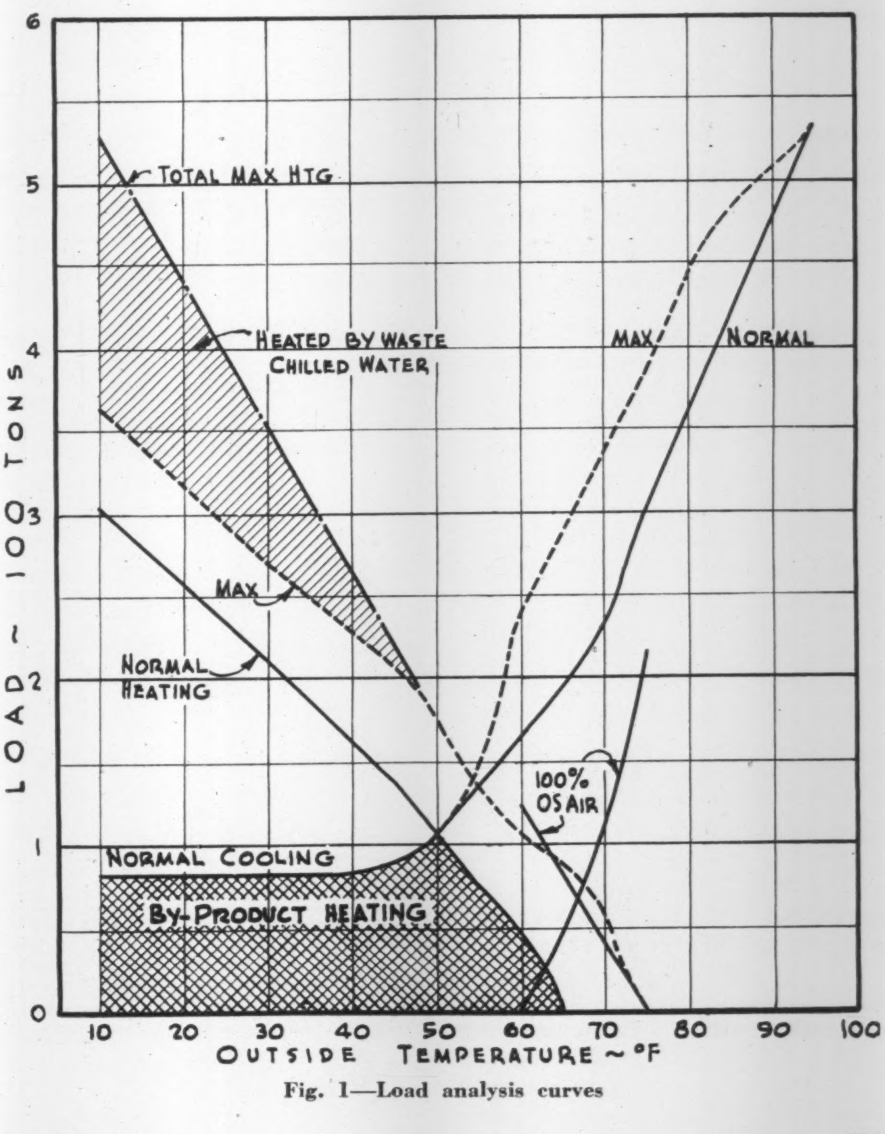

Fig. 1—Load analysis curves

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*Consulting Engineer. Member of ASHVE.

**Office of J. Donald Kroeker. Associate Member of ASHVE.

Presented at the 54th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, New York, N. Y., February 1948.

sign conditions are shown in Fig. 2; winter design was based on 10 F.

Dehumidification a Necessity

Maximum desired room humidity of 55 percent and the latent heat load in the space established the maximum permissible dew point of entering air at 56 F. Further, since the temperature of air supplied to the rooms at an outside temperature below 80 F was definitely higher than 56 F, it was apparent from a study of charts similar to Fig. 3, May 28, 29, July 14, 15, and Sept. 4, that dehumidification was required.

Dehumidification is required most frequently in Portland at temperatures between 60 and 80 F; accounting for divergences of maximum cooling lines in this temperature bracket, Fig. 1, and rapid decline in maximum cooling load at temperatures below 60 F.

Decision to use the refrigeration cycle for heating, limited selection of air conditioning and heating means and precluded application of a split system other than by floor panel heating which was not properly adaptable due to difficulty in zoning and unpredictability of furnishings or floor coverings in a rental office space. Heating and cooling by air exclusively was the system adopted.

Air Conditioning System Described

Air distribution by means of ducts concealed in furred ceiling spaces and ceiling diffusers of a type available in 4-way, 3-way, and 2-way diffusion is provided. This flexibility in diffusion from any outlet places minimum restrictions on partition placement.

Air returns at exposures to remove the cold air during heating consist of slotted window stools and small grilles near the floors. Return of air from interior spaces is provided through perforated flanges of wire gutters used to support cold cathode lighting fixtures spaced 8 ft and extending the length of the building. Since the structure is of fireproof construction, furred ceiling spaces are used as recirculation plenums, Figs. 4 and 5.

The air distribution system for a typical floor as a whole is shown in Figs. 6 and 7. Supply fan and coil equipment for the typical floors are located above the toilet rooms, and the exhaust fans over the lobby. These are the only two areas on the floors having reduced ceiling heights, Fig. 7.

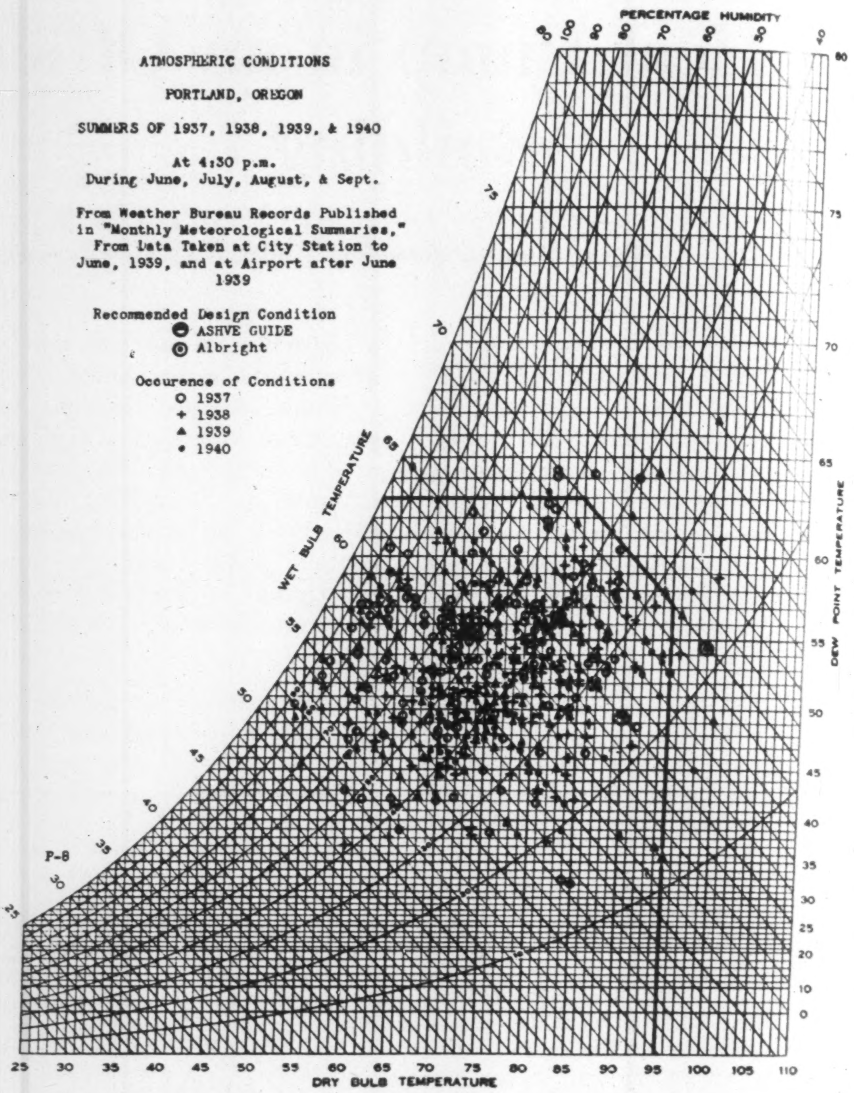


Fig. 2—Summer atmospheric conditions for Portland, Ore.

Table 1—Basic Heat Load Data
(In 1000 Btu per hour)

No.	Space	Total Heating Load	Heat Gains				
			Sensible to Room	Sensible Absorbed	Total Sensible	Latent Heat	Total Gain
1.	Basement, 1st & Mezzanine	400	500	100	600	100	700
2.	Restaurant		85	10	45	25	120
3.	Cafeteria		25	5	30	5	35
4.	Second floor	120	320	60	380	90	470
5.	9 Typical floors	1215	1944	270	2214	432	2646
6.	Twelfth floor	158	268	30	298	48	346
7.	Penthouse	58	90	14	104	11	115
8.	Net Totals	1951	3232	489	3721	711	4432
9.	Ventilation	3894	1070			475	1545
10.	Safety Factor	585					598
11.	Gross Load	6430					6575
12.	Recovery[a]	2080					0
13.	Equipment Load	4350					6575

[a] Reduction of load by use of waste water and recovery of heat from exhaust air for preheating ventilation air.

Due to dehumidifying requirements, warm and cool plenum systems are provided, and air from them is mixed as required by 11 zone thermostats for the typical floors; one for each exposure, one for each corner where there are two exposures, one for the interior areas, and two additional zones for the east side where shading by a tall building across the street affects heating requirements, Fig. 8. Thermostats, also located to be unaffected by unpredictable repartitioning, are reset as required from the basement mechanical equipment room, where recording and indicating instruments indicate temperatures at five points per floor. One humidistat per floor, also subject to reset from the basement mechanical equipment room, controls dehumidification. Alternate thermostat locations are roughed in for use in the event thermostats as located are affected by nonrepresentative conditions of occupancy.

100 Percent Outside Air Used To Effect Economy

One hundred percent outside air can be used for flushing, if desired, by manual control from the mechanical equipment room. Normally it is controlled by an outside thermostat reset by a humidity controller to reduce heat pump load when the temperature ranges between 60 and 75 F dry bulb and the dew point is, roughly, below 55 F. The average of the monthly mean

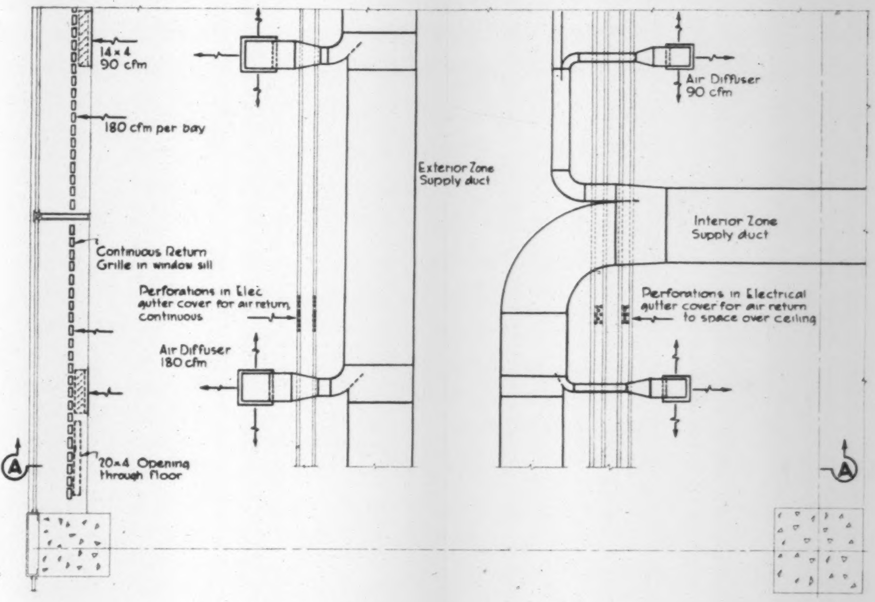

14×4
90 cfm
180 cfm per bay
Continuous Return Grille in window sill
Perforations in Elec. gutter cover for air return, continuous
Air Diffuser 180 cfm
20×4 Opening through floor
A
Exterior Zone Supply duct
Air Diffuser 90 cfm
Interior Zone Supply duct
Perforations in Electrical gutter cover for air return to space over ceiling
A

Fig. 4—Floor plan—typical air distribution

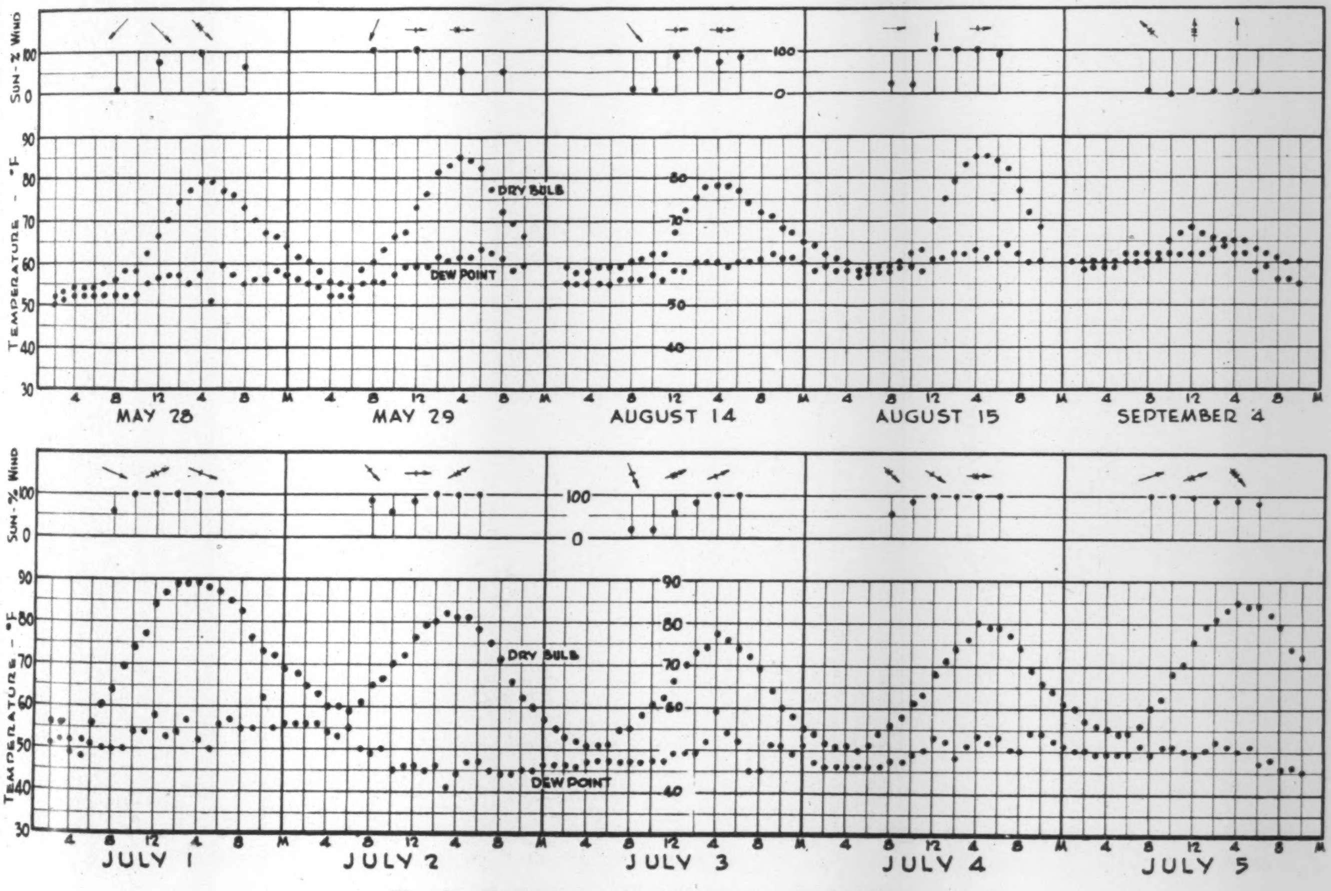


Fig. 3—Typical march of temperature, 1945

temperature being 53.0 F, much of Portland's weather falls in this bracket. Many days occur from March to November which are typified by conditions shown for July 1 to 5 in Fig. 3, during which outside air may be used exclusively for at least a half day. The effect of this load reduction on the heat pump is shown in Fig. 1.

Heat Pump—Water to Water

The basic scheme in application of the water to water heat pump to the air conditioning system described in general is shown in Fig. 9, with the flow during the heating cycle indicated. The typical room air circuit occurs on 13 levels. The heat source is well water pumped from two warm wells, roughly 150 ft deep, one of 64½ F at 195 gpm, the other of 62½ F at 450 gpm, and is disposed to a 57 F well 510 ft deep. Four condensing units of the hermetically-sealed, diffusion-centrifugal, constant-speed type, two of 200 rated ton capacity using Freon 11 and two of 70 ton rated capacity using Freon 113, are the basic heat pumps. In addition to circulating pumps in separate heating and cooling circuits shown, *settling tank* pumps are used to introduce well water from a settling or storage tank into the heating or cooling circuits as discussed in following paragraphs. Only basic control valves are shown in Fig. 9.

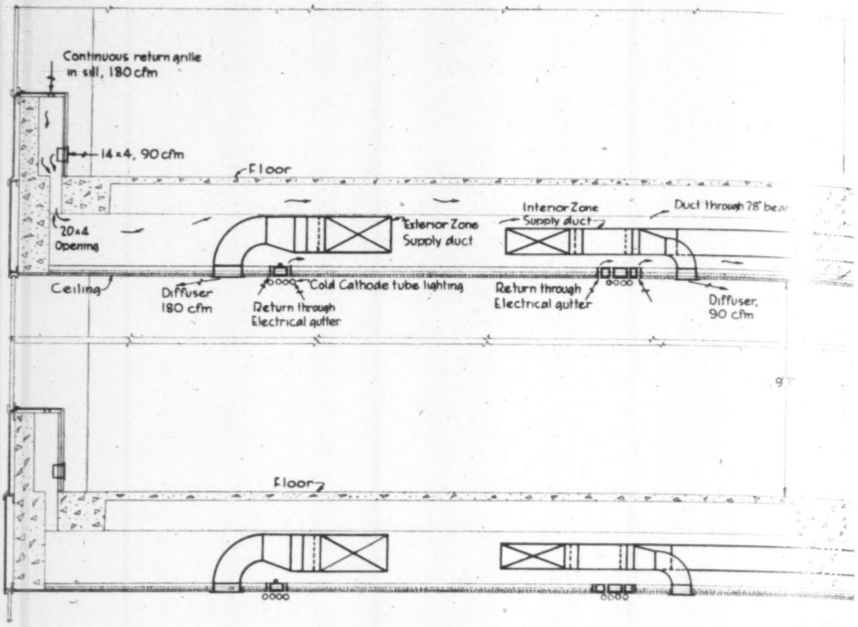

Continuous return grille in sill, 180 cfm
14x4, 90 cfm
Floor
20x4 Opening
Ceiling
Diffuser 180 cfm
Return through Electrical gutter
Cold Cathode tube lighting
Exterior Zone Supply duct
Interior Zone Supply duct
Duct through 28" bea
Return through Electrical gutter
Diffuser, 90 cfm
9'7"
Floor

Fig. 5—Section A-A—typical air distribution

The heating or warm water circuit is a closed system when heating is the greater, during which time a thermostat in the return, through a step controller, determines the number and selection of condensing units to be operated. The evaporator or cooling circuit receives well water through settling tank pumps in a quantity determined by thermostat T1 in the chilled water return, operating valve W1. The chilled water is circulated to cooling coils in the fan units and then, after recovering heat from exhaust air and in turn heating ventilation air, is wasted to the casing of the cool well. The latter is shown in further detail in Fig. 10.

Flow Diagrams Traced For Three Conditions

With condensing unit 1, Fig. 10, in service, the upper or condenser section increases the temperature of water circulated, supplies the several fan units through valve W5, from which the water returns through valve W6 to the heating pumps, which supply to unit 1. If the return temperature is too low, immersion thermostat T2, reset by outside temperature, starts additional condensing units through a step controller and selector. The system is closed.

From the heat source side, deep well pumps DP1 and DP3 in the warm wells operate at the command of float switches in the

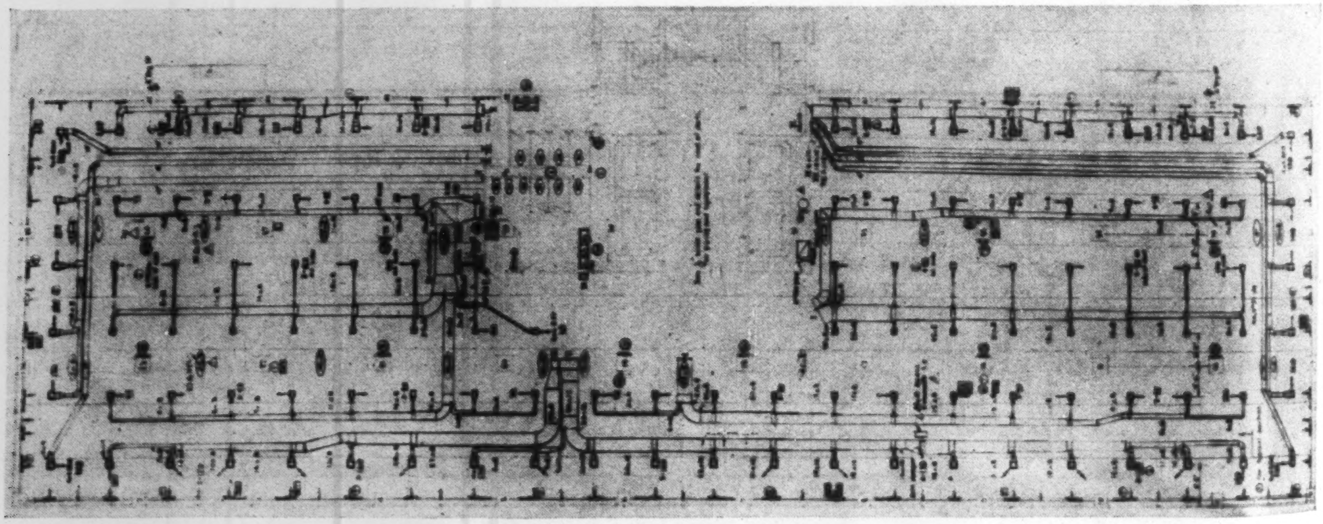


Fig. 6—Typical floor plan

settling tank. Settling tank pumps supply water into the chilled circuit through valve W1, modulated by T1, through cooling pumps to the evaporator section of the condensing unit, from which the well water is supplied to the fan units, providing cooling, necessary in some zones at all seasons. Valve SW4 permits by-passing warm water through spring-loaded differential-pressure relief valve S4. Valve S3, similarly a differential-pressure relief valve, prevents the pumping head from becoming excessive as the head rises due to the use of a single condensing unit. The return for the basement coils then passes through a recovery coil in the air exhaust stream, picking up heat, and thence to the pre-conditioning coil, where ventilation air is heated with the water normally wasted. The chilled water is then wasted through relief valve S1 to the casing of cool well 2, indicated as DP2. The number of settling tank pumps in operation is determined by a flow meter in the pump discharge.

The use of a recovery coil and preconditioning air with waste water results in reduction by one-third of the heating load at design conditions, Fig. 1.

As heating and cooling loads reach equality, shown at 50 F outside temperature in Fig. 1, no well water is introduced and heat interchange without an outside source obtains.

Changes as Cooling Becomes The Greater

As the outside temperature rises further or as cooling load becomes the greater, immersion thermostat T1 in the return from the cooling coils takes command of the condensing unit operation through the step controller and selector. Certain valves are repositioned and the chilled water circuit becomes a closed system.

During this condition when cooling is the greater and until the outside temperature reaches 75 F, the flow is as shown in Fig. 11. Deep well pump DP2, supplying 57 F water, delivers well water to the settling tank through valve W9. The settling tank pumps supply through valve W2 at command of thermostat T2 in the warm water return to the condenser of unit 1, thence to the fan units, to be wasted through spring-loaded pressure relief valve S2 to the casings of deep wells DP3 and DP1, through valves W10 and W11. Recovery and preconditioning coils are by-passed during this period. The number of settling tank pumps in operation is again determined by the flow meter in the settling tank pump discharge.

When the outside temperature exceeds 75 F and heating or reheating for dehumidification is unnecessary, the flow shown in Fig. 12 obtains. Valves W5 in the warm water supply and W6 in the return are closed, settling tank pumps are off, valve W3 is open from the settling tank to the heating pumps which, operating at low speed, are controlled by the flow meter in their discharge and are used to supply well water. The amount of well water supplied is regulated by a low-pressure limit control in the condenser of each heat pump. The condenser circuit by-passes the fan units, flowing to deep wells DP1 and DP3 through valve W4, and thence through valves W10 and W11.

An important feature of the heat pump control is the provision to close valves in the hot and chilled lines to the individual machines whenever a machine is not in operation. This prevents mixing of

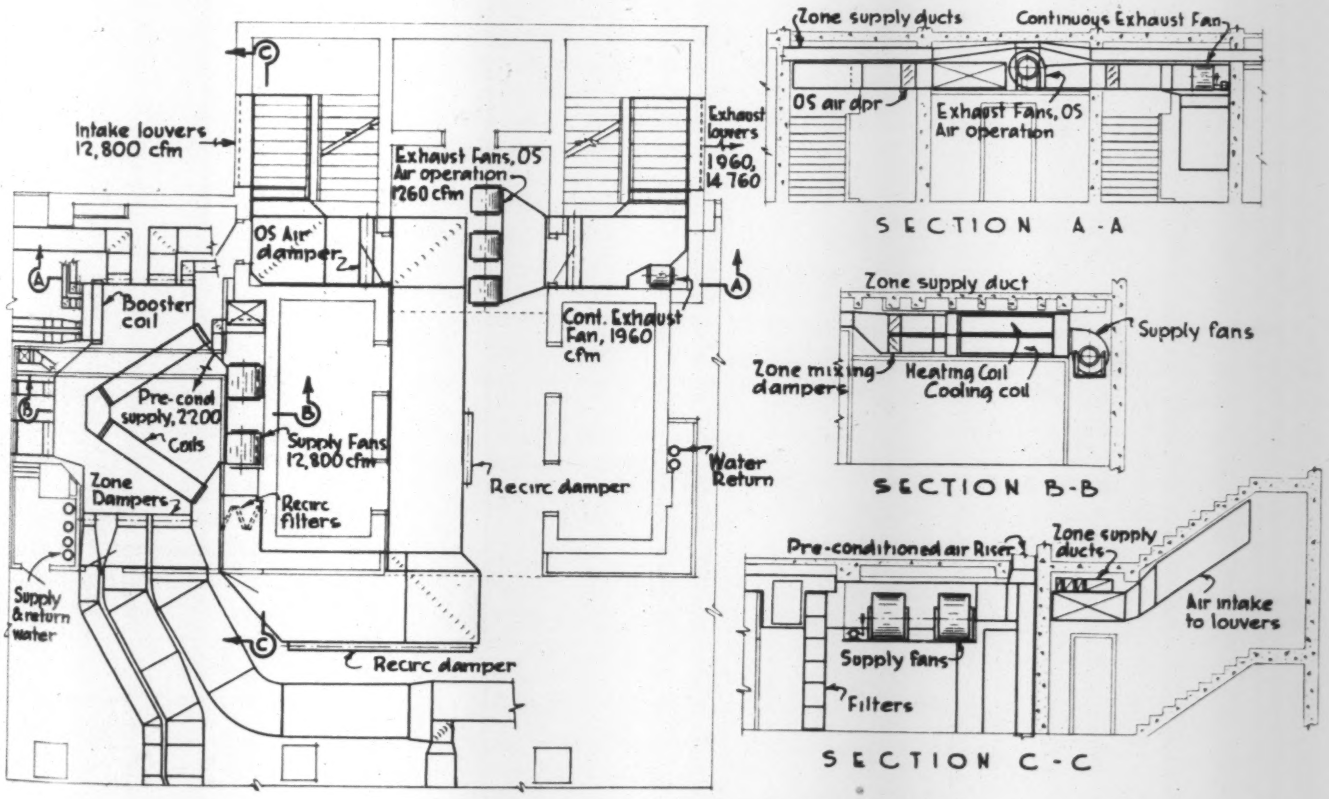

Intake louvers 12,800 cfm
Exhaust Fans, OS Air operation 1260 cfm
Exhaust louvers 1960, 14 760
OS Air damper
Booster coil
Cont. Exhaust Fan, 1960 cfm
Pre-cond supply, 2200
Coils
Supply Fans 12,800 cfm
Zone Dampers
Recirc filters
Recirc damper
Water Return
Supply & return water
Recirc damper
A
B
C
Zone supply ducts
Continuous Exhaust Fan
OS air dpr
Exhaust Fans, OS Air operation
SECTION A-A
Zone supply duct
Supply fans
Zone mixing dampers
Heating Coil
Cooling coil
SECTION B-B
Pre-conditioned air Riser
Zone supply ducts
Air intake to louvers
Supply fans
Filters
SECTION C-C

Fig. 7—Plan of typical floor equipment area

return and discharge water and the resulting extreme temperatures which would be required from the machines in operation to maintain the temperatures at which the thermostats T1 and T2 control.

Water Quantities and Temperatures Shown

Approximate maximum water capacities of the pumps are shown in the flow diagrams, Figs. 10, 11, and 12.

At design heating conditions, 10 F outside, the water leaves the condenser at 101 F and returns at 86 F. On the chilled water side, 600 gpm at an average temperature of 63.6 F is injected into the chilled return to give 900 gpm of 58.7 F water, which leaves the chiller at 50.4 F, the cooling coils at 52.5 F, the recovery coil at 53.7, and finally the preconditioning coil at 49 F, from which 600 gpm is wasted and the remainder is recirculated.

At design cooling condition, 95 F dry bulb, 70 F wet bulb, the chilled water supply is 42 F and the return 56.4 F; 600 gpm of 57 F well water being supplied to the condensers and rejected at 83 F.

Changeovers Completely Automatic

Operation under each of the conditions described and shown in the flow diagrams is completely automatic. There is no manual changeover of a single valve or even switch.

Automatic control of the system involving the quantities of water used and constantly changing conditions prevailing was seen at the outset as the safest and most economical. However, the problems involved in providing automatic control in a system as diversified and versatile as any heat pump application must be, are extensive. Control diagrams are not presented herein inasmuch as they will vary widely with specific applications.

No Auxiliary Heat Provided

Another unusual feature of the heat pump installation is that it has no provision of auxiliary heat, which to date has been incorporated in other applications larger than residential. The capacity required for cooling was so far in excess of that necessary for heating, since one-third of the load at heating design temperature was provided by waste chilled water, Fig. 1, that no auxiliary source was seen justified.

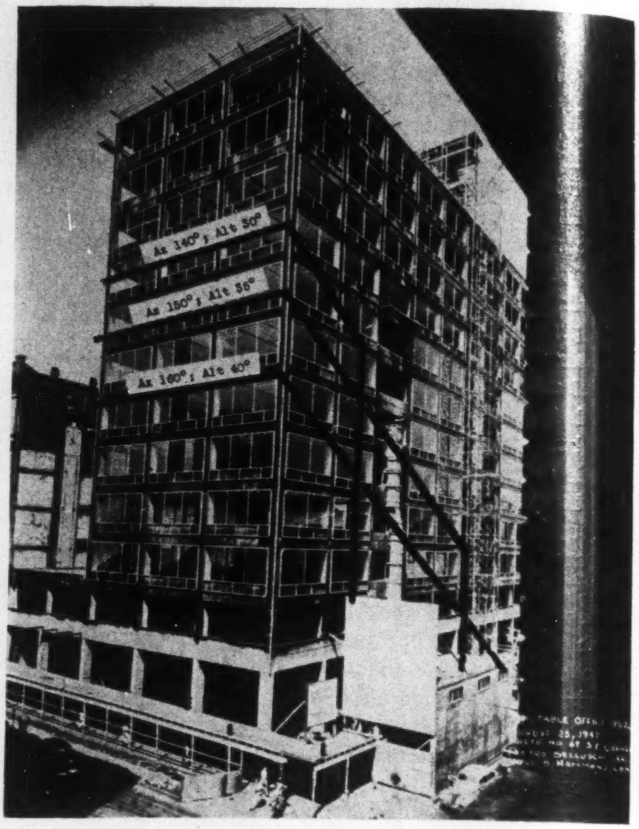


Fig. 8—Construction view of the Equitable Building showing shading by other building, October 15 and March 1. Azimuth 140 deg at 9:00 a.m., 150 deg at 9:45, 160 deg at 10:30

Costs Discussed

Decision to accomplish heating by means of the heat pump was reached after considering first and operating costs, both showing economical feasibility.

Use of the district steam available in heating coils would have made temperature control by air mixing from plenum chambers less accurate and would have required greater cooling capacity to offset damper leakage. The same was seen true, though to a lesser degree, in use of district steam to heat water for circulation through the coils in the fan units. The saving in first cost by either system was seen as being within one percent of that of the installation as made. Cost of the installation complete was $0.29 per cu ft, or roughly $1,250.00 per rated ton.

While average operating costs cannot be accurately predicted, and were expected to vary widely with seasons, reasonably reliable comparisons were made. On the basis of a coefficient of performance for heating of 3.5, a 7-mill per kilowatt hour power rate, and a weighted value of waste chilled water utilization, a cost of $0.46 per million Btu for heating was estimated. The applicable rate indicated for district steam during design was 22 percent higher. Steam rates have increased since that time. Power rates declined as late as the spring of 1947.

Detailed Operating Cost Estimates Made

During design, as more complete data were developed, the power serving company, desirous of investigating operating costs of a heat pump in an office building, made such cost estimates, shown graphically in Fig. 13. Inasmuch as power costs on applicable schedules are based on monthly maximum 30 min. sustained demands as well as power consumption, extreme load conditions, both heating and cooling, were as important in arriving at costs as were average monthly load conditions. Thus, while either average or mean monthly temperature data might form a suitable basis for consumption computations, mean maximum monthly, mean minimum monthly data, or means of the maximum and mini-

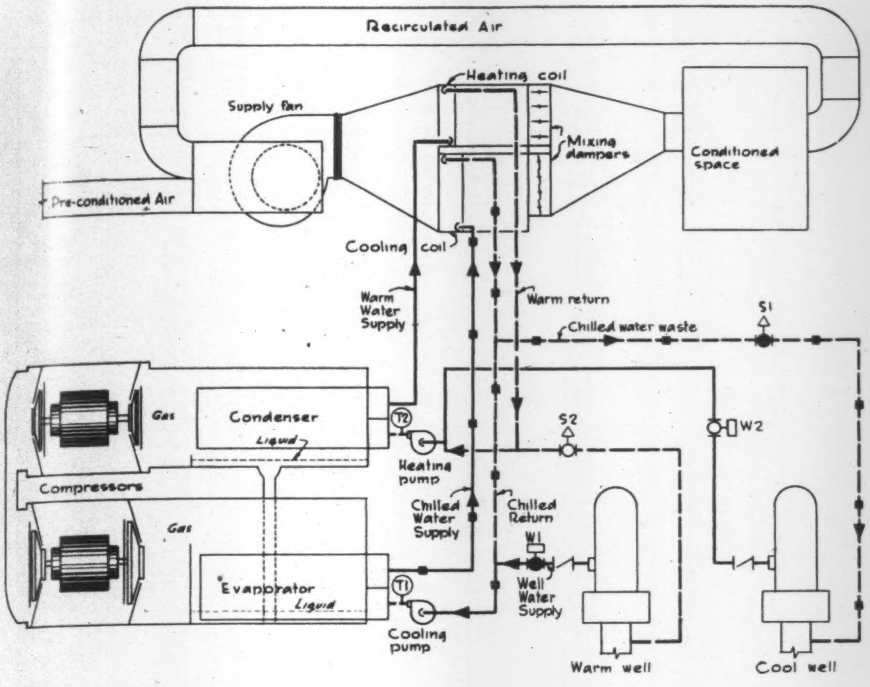

Recirculated Air
Heating coil
Supply fan
Mixing dampers
Conditioned space
Pre-conditioned Air
Cooling coil
Warm Water Supply
Warm return
Chilled water waste
S1
Gas
Condenser
Liquid
T2
Heating pump
S2
W2
Compressors
Chilled Water Supply
Chilled Return
W1
Gas
Evaporator
Liquid
T1
Well Water Supply
Cooling pump
Warm well
Cool well

Fig. 9—Basic heat pump scheme, heating cycle

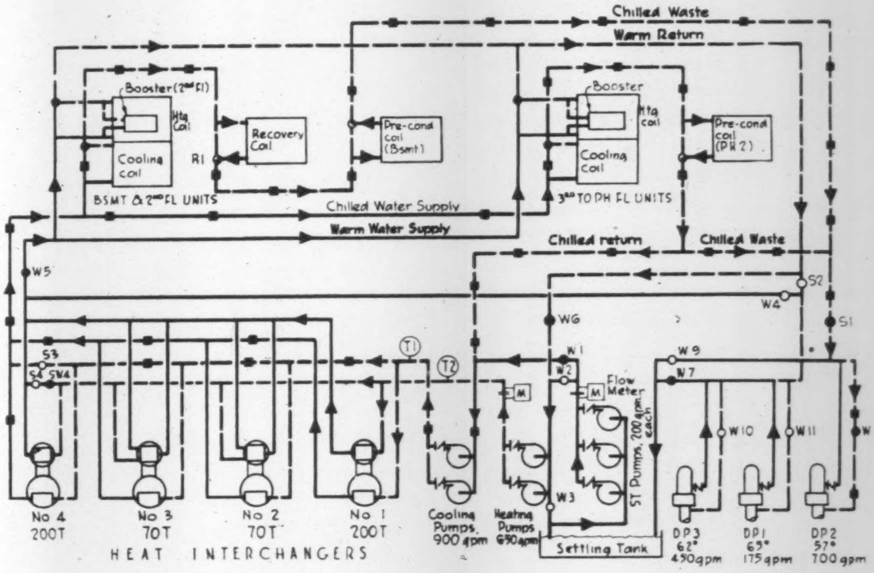
mum data were proper for determination of demands, since great variations in extremes occur monthly. It was therefore determined to base an estimate on a year having complete temperature history. The year 1940 was chosen as representative. Detailed, virtually day-by-day studies were made for this year, with loads *vs* temperatures taken from Fig. 1.

Heating Is Largely By-Product

During all normal heating weather a supply of by-product heat is available from cooling, Fig. 1. Had steam been used for heating, this by-product would have been wasted. The heat pump made its utilization possible. Further, since air conditioning was a requirement, this cooling load was present in any case. Actually there was no heating period and no cooling season as such. It was difficult to discard the age-honored concept that there must be these two separate seasons and that comfort below 65 F outside must be charged to heating. Yet, in this instance, this clearly was not the case. In computing its estimate, the power serving company was therefore requested to charge to heating only the heating load in excess of the by-product from cooling. Further, on the same basis, the company was requested to charge to heating only the portion of the maximum heating demand for any month which exceeded the maximum cooling demand for that month.

Another factor apparent on preliminary analysis was that the estimated building demand normally occurs at 4:30 p.m. and that, except at design heating conditions which do not recur each year, the morning pick-up load does not impose the maximum demand, mak-

Fig. 10—*(Below)* Flow and control diagram, heating load the greater


Chilled Waste
Warm Return
Booster (2nd Fl)
Htg Coil
Recovery Coil
Pre-cond coil (Bsmt)
Cooling coil
R1
BSMT & 2nd FL UNITS
Booster
Htg coil
Pre-cond coil (PH 2)
Cooling Coil
3rd TO PH FL UNITS
Chilled Water Supply
Warm Water Supply
Chilled return
Chilled Waste
W5
S2
W4
W6
S1
S3
S4 SW4
T1
T2
W1
W2
W9
W7
M
M Flow Meter
W10
W11
W8
W3
ST Pumps, 200 gpm each
No 4 200T
No 3 70T
No 2 70T
No 1 200T
HEAT INTERCHANGERS
Cooling Pumps 900 gpm
Heating Pumps 650 gpm
Settling Tank
DP3 62° 450 gpm
DP1 65° 175 gpm
DP2 57° 700 gpm

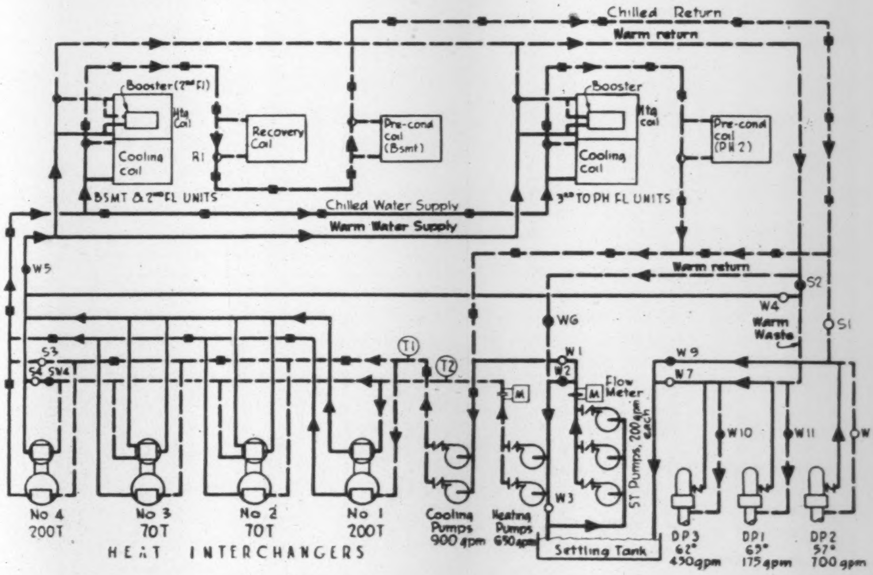

Chilled Return
Warm return
Booster (2nd Fl)
Htg Coil
Recovery Coil
Pre-cond coil (Bsmt)
Cooling coil
R1
BSMT & 2nd FL UNITS
Booster
Htg coil
Pre-cond coil (PH 2)
Cooling Coil
3rd TO PH FL UNITS
Chilled Water Supply
Warm Water Supply
Warm return
W5
S2
W4
Warm Waste
W6
S1
S3
S4 SW4
T1
T2
W1
W2
W9
W7
M
M Flow Meter
W10
W11
W8
W3
ST Pumps, 200 gpm each
No 4 200T
No 3 70T
No 2 70T
No 1 200T
HEAT INTERCHANGERS
Cooling Pumps 900 gpm
Heating Pumps 650 gpm
Settling Tank
DP3 62° 450 gpm
DP1 65° 175 gpm
DP2 57° 700 gpm

Fig. 11—Flow and control diagram, cooling load the greater to 75 F

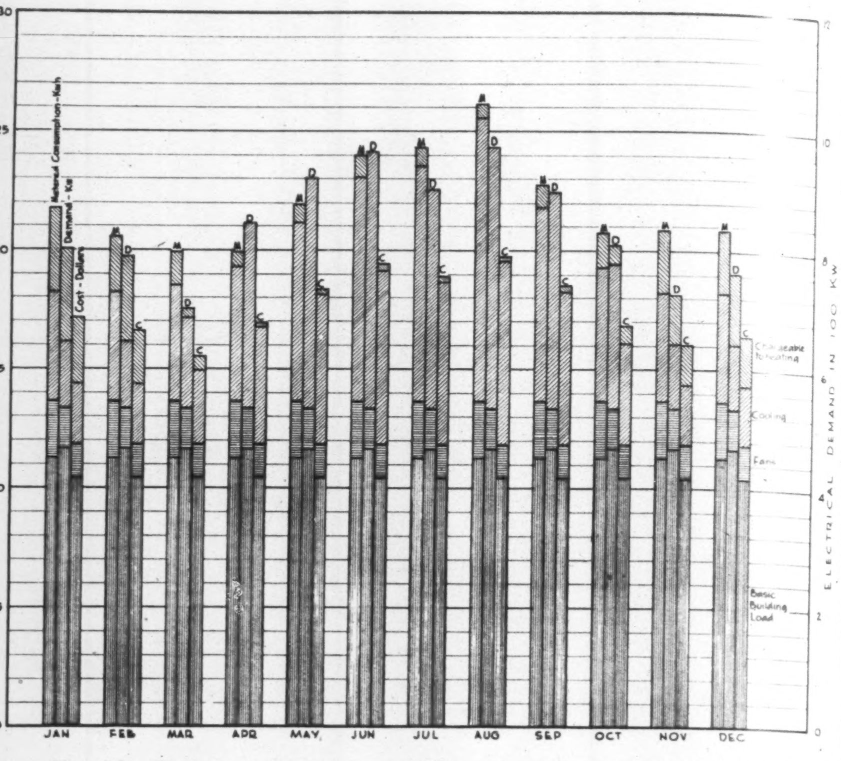


Fig. 13—Power consumption and demands and costs, based on 1940

ing it necessary to investigate only the 4:30 p.m. conditions.

Heating COP for Representative Year Computed

The normal building demand for lights and power, chiefly for elevators, was estimated at 468 kw, the monthly consumption at 113,000 kwhr. The constant fan load was estimated at 67 kw and 23,692 kwhr. On these as bases, the demands and electrical consumptions of the heat pumps were superimposed in a graph, showing power consumption, Fig. 13. All power consumption in excess of 100,000 kwhr. is billed at 3.15 mills, all demand in excess of 10 kw at $1.00 per kilowatt.

The heating load for 1940 integrated under normal heating curves, plus heating accomplished with chilled waste water, Fig. 1, was computed at 5.01 billion Btu, the power consumption chargeable to heating at 99,000 kwhr or 340 million Btu. Related to each other these figures result in the fantastic *job COP* for heating of 14.8. Including auxiliaries chargeable to heating, this *job COP* for heating drops to 7.8.

Auxiliaries include deep well pumps, settling tank pumps, and warm water circulating pumps. Inclusion of the latter in auxiliaries chargeable to heating is questionable, inasmuch as had steam been used for heating, a hot water generator would have been provided to furnish warm water for circulation to coils.

In general, in any complex heating and cooling system, a coefficient of performance is meaningless without detailed specification of division of load between heating and cooling as herein attempted.

In this application, if it had been contemplated to use steam for heating with the heat pump adapted independently for cooling, the internal cooling, or the minimum cooling requirement shown in Fig. 1, would have been accomplished with outside air reheated as required at temperatures below 60 F, and a COP materially lower would have been shown.

Outside air was not used for the internal or minimum cooling, inasmuch as to do so would have required equipment arrangement on each floor, encroaching on rentable floor space and would have necessitated additional complexity in automatic control.

Operating Cost Data Being Compiled

Interest in heat pump application having risen sharply, the power serving company is providing extensive metering devices for the heat pump equipment in this installation, so that, with extensive water flow metering and air and water temperature recording instruments of the installation, reasonably accurate data on actual operating power requirements and costs may be established and should be available in the spring of 1949. It is contemplated that frank comparisons will be made between actual operating experience and costs as against those predicted from careful analyses during design.

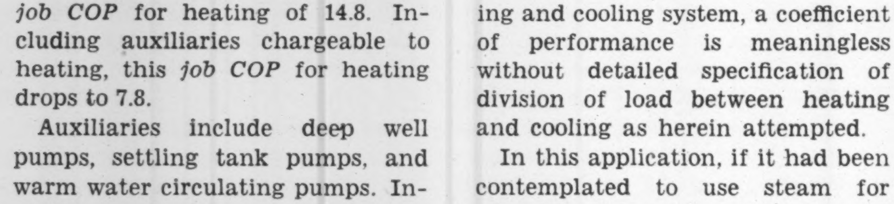

Chilled Return
Booster (2nd Fl)
Htg Coil
Cooling coil
R1
Recovery Coil
Pre-cond coil (Bsmt)
BSMT & 2nd FL UNITS
Chilled Water Supply
Booster
Htg coil
Cooling Coil
Pre-cond coil (PH 2)
3rd TO PH FL UNITS
W5
Warm Water Waste
S2
W4
W6
S1
S3
S4
SV4
T1
T2
W1
W2
M
Flow Meter
W9
W7
W10
W11
W8
W3
ST Pumps, 200 gpm each
No 4 200T
No 3 70T
No 2 70T
No 1 200T
HEAT INTERCHANGERS
Cooling Pumps 900 gpm
Heating Pumps 650 gpm
Settling Tank
DP3 62° 450 gpm
DP1 65° 175 gpm
DP2 57° 700 gpm

Fig. 12—Flow and control diagram, cooling above 75 F

Downward Projection of Heated Air

By Linn Helander* and C. V. Jakowatz, Manhattan, Kans.**

This paper is the result of research sponsored by the *American Society of Heating and Ventilating Engineers* in cooperation with the Engineering Experiment Station of Kansas State College

SUMMARY—The general character of a heated stream projected downward from a simple orifice is described. Air streams were projected downward from a straight run of 6.5 in. diameter pipe and from a convergent nozzle 5.75 in. in diameter. Formulas derived analytically were found usable in making practical estimates within the range covered by tests. Test results are compared with theoretical flow

Introduction

UNDER the ASHVE Technical Advisory Committee on Air Distribution and Air Friction[1] a number of studies have been made to determine the factors governing the flow of air from outlets of different shapes, sizes and locations. This paper constitutes a progress report on the studies which have been under way since May 1945 on the downward projection of heated air, to determine:

1. How far downward heated air will flow when it is projected perpendicularly from a simple orifice.
2. The shape of the stream and its diameter at any level.
3. The rate at which such a stream entrains room air.

This paper presents: *(a)* a brief description of the general character of a stream of heated air projected downward, *(b)* a resume of a preliminary theoretical analysis of the flow of downwardly projected warm air, made primarily to derive simple formulas to serve as a guide in designing test equipment, but found *usable* in making practical estimates within the range of test results, *(c)* the results of two series of tests, one dealing with a stream projected from a straight run of pipe 6.5 in. in diameter, the other from a convergent nozzle having a 5.75 in diameter orifice, *(d)* a comparison of analytical results with test results, *(e)* a brief description of the apparatus employed and techniques used.

General Considerations

When heated air is projected vertically downward from a round orifice, it forms a moving stream which will be: *(a)* divergent for an appreciable fraction of the distance down from the orifice to the point of maximum downward travel, and *(b)* convergent or cup shaped for the remaining distance.

Over the principal portion of the divergent section of the stream, room air will be entrained. Over the convergent section, stream air will escape laterally across the stream boundary and turn upward.

Where room air is entrained, two forces will oppose the downward flow: *(a)* a buoyancy force due to the difference in density between the warm air stream and the surrounding air, and *(b)* an inertial resistance to downward acceleration offered by the entrained air.

Where no air is entrained, the inertial force will be absent but the buoyancy force will persist.

Other forces also will act upon the stream. Among them will be the pressure differentials set up by the stream in the space around it.

For some distance laterally from the stream, an upward current of air somewhat warmer than the undisturbed room air will predominate. The stream therefore will entrain air that will be neither still nor at the temperature of normal room air. Both the velocity and the temperature of the warm air stream increase from the periphery of the stream to its center.

Tuve, Priester, and Wright[2], in studying the flow of air projected horizontally into a room from orifices of various sizes and shapes, found that the stream of air formed a divergent cone with an apex angle of 19 deg ±5 deg. They found that the stream entrained room air at the same rate over each foot of its path, and that the momentum of the total amount of stream air passing a section of the stream in unit time was the same at all cross-sections of the stream. These conclusions would also apply to a stream of unheated air projected downward, but, with heated air, buoyancy forces are set up giving the pattern of flow previously described.

Preliminary Theoretical Considerations

An elementary analysis of the flow of downwardly projected warm air was made as a first step in organizing a program of research. To reduce the complexity of the analysis the following simplifying assumptions were made:

1. The stream of warm air was projected into an unbounded atmosphere of still air of uniform temperature.
2. The only forces opposing the downward flow were *(a)* the buoyancy forces, and *(b)* the inertial forces due to the entrainment of room air.
3. The air entrained by the stream was still air at room temperature.
4. The downward velocity and the temperature of the stream at any horizontal section were uniform.
5. The only cooling effect on the stream was that due to the entrainment of room air.
6. The lateral velocity of the stream air leaving the bottom portion of the stream was expressible as a constant

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**Instructor, Department of Mechanical Engineering, Kansas State College.

[1] COMMITTEE PERSONNEL: Ernest Szekely, *Chairman;* N. E. Berry, S. H. Downs, W. H. Hoppmann, II, F. J. Kurth, J. N. Livermore, R. D. Madison, G. E. McElroy, L. G. Miller, D. W. Nelson, G. B. Priester, C. A. Thorp, T. H. Troller, J. H. Van Alsburg.

Presented at the 54th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, New York, N. Y., February 1948.

[2] Entrainment and Jet-Pump Action of Air Streams by G. L. Tuve, G. B. Priester, and D. K. Wright, Jr. (ASHVE TRANSACTIONS, Vol. 48, 1942, p. 241)

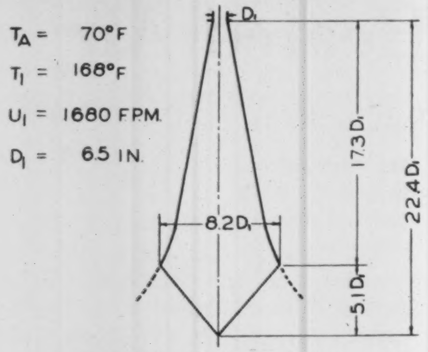


Fig. 1—Idealized shape of air stream (Case 1)

fraction of the downward velocity of the stream at the level of escape.

The last assumption gives the bottom portion of the idealized stream the shape of a cone with an apex angle which varies with the ratio that the lateral velocity of escape is assumed to bear to the downward velocity of the stream. The idealized stream is shown in Fig. 1.

In Case 1 dealt with mathematically, it was assumed that the rate at which room air was entrained by the divergent portion of the stream was a constant for each foot of downward travel and that it was directly proportional to the mass rate of flow of orifice air divided by the diameter of the orifice. In Case 2 this rate was assumed to be a variable and directly proportional to the mass rate of flow of stream air at the level of entrainment divided by the diameter of the stream at this level. The factor of proportionality in both cases was assumed to be 0.334. For the bottom or convergent portion of the stream, the lateral velocity of the escaping stream air was assumed to be the same as the downward velocity of the stream at the level of escape. The formulas developed under Case 1 are given in the Appendix.

A simple formula for estimating the maximum downward blow was derived by assuming that:

1. The rate of room air entrainment over each foot of stream travel would be a constant for the entire downward path of the stream and
2. The downwardly moving stream would therefore be continuously divergent.

$$\frac{L_{max}}{D_1} = \frac{1}{a}\left[\left(\sqrt{\frac{aU_1^2/gD_1}{(T_1/T_a)-1}+1}\right)-1\right] \qquad \text{(1)}$$

where

L_{max} = maximum downward travel or blow, in feet
D_1 = diameter of orifice in feet
U_1 = velocity of stream air at orifice in feet per second
T_1 = absolute temperature of stream air at orifice in degrees Fahrenheit
T_a = absolute temperature of room air in degrees Fahrenheit
a = pounds of room air entrained by each pound of orifice air per orifice diameter of stream travel, and assigned a tentative value of 0.334

Fig. 2 shows the close agreement between Cases 1 and 2 for the velocities and dimensions of the two idealized streams. The value U/U_1 is the ratio of the stream velocity to the orifice velocity, D/D_1 is the ratio of the stream diameter to the orifice diameter. The curves are plotted against distance down from the orifice measured in orifice diameters. Room air entrainment ceases at the point of discontinuity, and thereafter, until the end of the downward blow, stream air leaves the stream envelope. The assumed conditions are: *(a)* orifice diameter 6 in., *(b)* orifice velocity 320 fpm, *(c)* orifice air temperature 220 F above room temperature. In both these cases the maximum downward blow is in close agreement with the maximum downward blow evaluated by means of Equation 1. Values for the maximum downward blow expressed in orifice diameters L/D_1 is 2.26 for Case 1 and 2.28 for Case 2. A similar order of agreement was found when the assumed orifice velocity was changed to 7200 fpm.

Fig. 3 shows the rates of room air entrainment assumed as a basis for Fig. 2. The rates of room air entrainment are expressed in pounds of room air entrained per orifice diameter of stream travel per pound of orifice air, or as $\frac{D_1 dM}{M_1 dL}$

where

M = mass rate of flow across horizontal section of the stream, pounds per second

The stream velocity at the point of discontinuity is equal to approximately

$$450\sqrt{\left(\frac{T_1}{T_a}-1\right)D_1}\ \text{fpm.}$$

If the value for the ratio of the lateral velocity of escape to the downward velocity of the stream

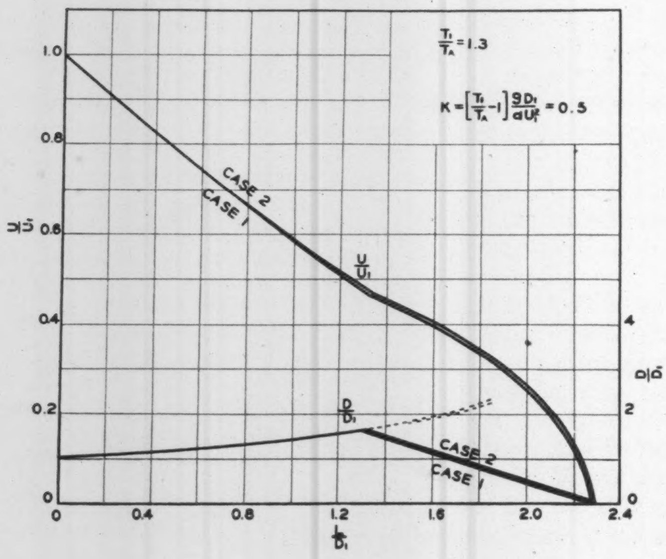


Fig. 2—Ratio of stream velocity to orifice velocity and stream diameter to orifice diameter plotted against distance down from the orifice in orifice diameters

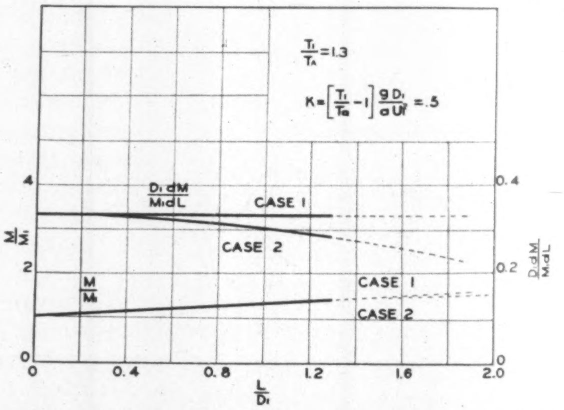
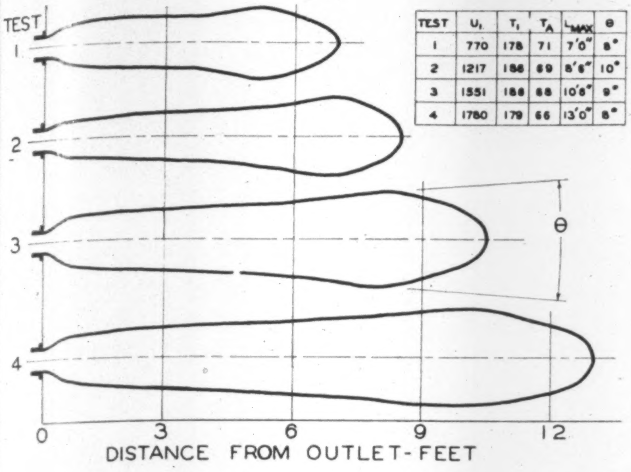


Fig. 3—Rates of room air entrainment assumed as basis for Fig. 2



TEST	U_1	T_1	T_A	L_{MAX}	θ
1	770	178	71	7'0"	8°
2	1217	186	69	8'6"	10°
3	1551	186	68	10'6"	9°
4	1780	179	66	13'0"	8°

Fig. 4—Shape of air stream at different orifice velocities

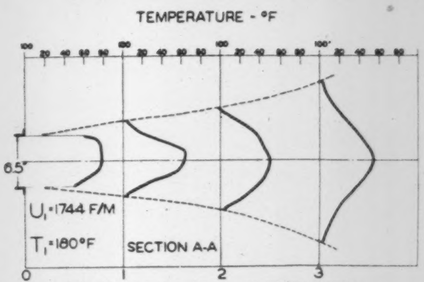


Fig. 6—Temperature distribution near outlet, 6.5 in. diam straight nozzle

had been made less than 1.0, the entrainment of room air would have ceased earlier in the path of the theoretical stream and maximum blows would have been somewhat larger than the values given.

Test Results and Comparisons of Test and Theoretical Results

Fig. 4, revolved 90 deg clockwise, shows the shape of the air stream developed from data obtained from four tests. Four streams of different lengths or maximum blows, corresponding with different orifice velocities, are shown. The orifice diameter in each case was 6.5 in. and the initial stream air temperature was about 180 F. The room air temperature varied between 66 and 71 F. Except for the bulge close to the orifice the shape of the streams is in fair agreement with that shown in Fig. 1. The bulge was caused by an apron on the platform that supported the orifice. When the orifice was dropped two feet so as to clear this apron, the bulge disappeared, and the jet angle increased by 3 or 4 deg to a value of about 12 deg. The jet angle is difficult to measure accurately, and in later tests, with the same orifice, values varying between 15 and 19 deg were obtained. Fig. 5 shows velocity readings taken at the orifice after it was dropped 2 ft and at distances 1 ft, 2 ft, and 3 ft below the orifice.

Fig. 6 shows a plot of the corresponding temperature readings.

Figs. 7 and 8 show data obtained in tests using a convergent nozzle with an orifice 5.75 in. in diameter.

Fig. 9 is a graph of measured values of the maximum downward blow from a nozzle made of straight pipe 6.5 in. in diameter, against the calculated values. The points, in the main, fall within a band 2 ft wide which lies somewhat above and parallel to the line that represents Equation 1.

In Table 1, U_{Ave} is the average velocity of the stream obtained from the volume rate of flow, while U'_{Ave} is the corresponding velocity obtained from the rate of flow of downward momentum. As would be expected, the values do not agree. The tabulated data show that air entrainment ceases after the stream has traveled approximately 50 to 60 percent of its maximum downward travel; this is earlier in the path of the stream than would be indicated by the intersection of the convergent and divergent sections in Fig. 1. This fact suggests that for the analyses made under Case 1 and Case 2, the apex angle used for the bottom portion of the idealized stream should perhaps have been decreased.

Test No. 2 was made on a stream of air projected downward at room temperature. With an initial velocity of 1445 fpm, the stream of unheated air was found to have a centerline velocity of 235 fpm 17 ft down from the orifice. When the orifice velocity was reduced to 750 fpm, a centerline velocity of about 90 fpm was found 18 ft down from the orifice.

Fig. 10 shows the maximum downward blow from the converging

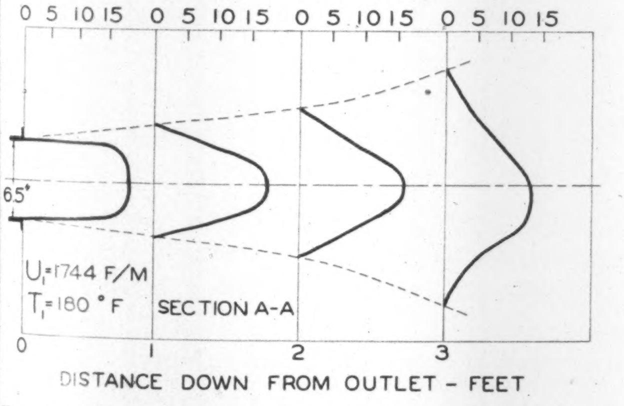


Fig. 5—Velocity distribution near outlet, 6.5 in. diam straight nozzle

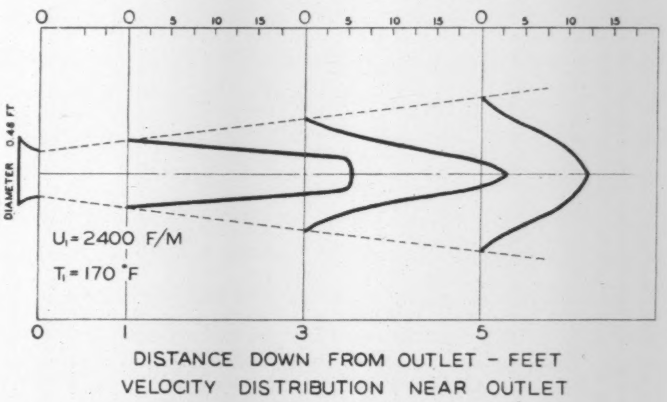


Fig. 7—Velocity distribution near outlet, convergent nozzle with 5.75 in. diam orifice

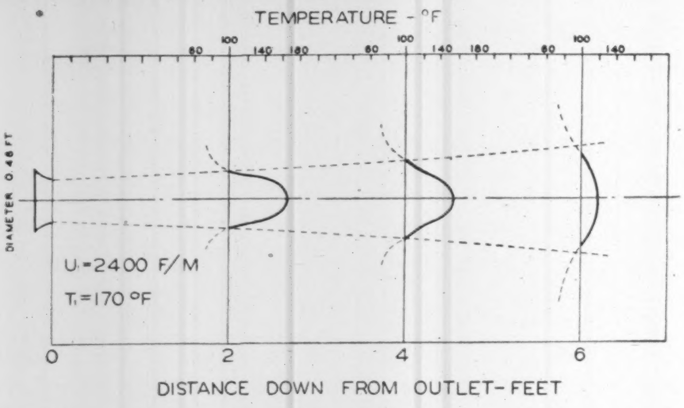


Fig. 8—Temperature distribution near outlet, convergent nozzle with 5.75 in. diam orifice

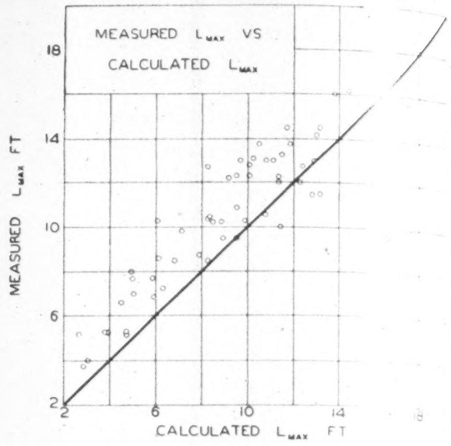


Fig. 9—Maximum downward blow 6.5 in. diam straight nozzle—measured values versus calculated values

nozzle with a 5.75 in. orifice diameter, measured values versus values calculated by means of Equation 1. The measured values are in closer agreement with Equation 1 than the measured values plotted in Fig. 9. In the main they fall short of the calculated values, whereas in Fig. 9 they were greater than the calculated values.

Fig. 11 shows the temperature readings plotted against distance down from the orifice. The ordinates represent the ratio of the absolute temperature of the stream along its axis to the absolute temperature of the room air.

Description of Test Equipment

The lower part of the experimental setup is shown in Fig. 12. Heated air was delivered to a plenum chamber, the base of which was 23 ft above the floor. The vertical frame constructed to support the temperature and velocity measuring equipment extended to the floor. Two Pitot tubes mounted on rotating arms were used to measure the velocity of the stream at points spaced either vertically or horizontally. While the upper Pitot tube was coupled to a draft gage, the lower was coupled to an analytical balance modified to measure small differentials of pressure. By this method increments of velocity of the order of 60 fpm could be meas-

Table 1—Results From Tests on Air Streams Projected Downward Through 6½ in. Nozzle Made of Straight Run of Pipe

Test No.	Distance down Feet	U_{Ave}/U_{1Ave}	T_{Ave} F	Quantity of Stream Air Flowing Lb Per Hour	Rate of flow of Downward Momentum Lb (force)	U_{Max} Fpm	U_{Max}/U_{Ave}	U'_{Ave}/U_{Ave}
1 Orifice Vel. 1380 fpm Orifice Temp. 167 F Room Temp. 73 F	0	1.000	167	1183	0.237	1500	1.09	1.05
	2	0.312	137	2090	0.215	1380	2.31	1.65
	4	0.245	130	2920	0.209	970	2.74	1.48
	6	0.176	122	3050	0.139	541	2.23	1.36
	8	0.103	115	1970	0.0533	298	2.10	1.33
	9	0.095	111	1172	0.0247	186	1.41	1.11
	9½	0.079	107	791	0.0127	157	1.44	1.03
	10¼	0.0	103	0	0.0	0	...	0
2 Orifice Vel. 1445 fpm Orifice Temp. 84 F Room Temp. 84 F	0	1.000	84	1420	0.300	1570	1.09	1.01
	2	0.450	84	2560	0.332	1460	2.25	1.33
	4	0.286	84	3500	0.329	1168	2.80	1.57
	6	0.212	84	4450	0.298	850	2.78	1.52
3 Orifice Vel. 1207 fpm Orifice Temp. 175 F Room Temp. 76 F	0	1.000	175	1010	0.176	1318	1.09	1.00
	2	0.371	155	1685	0.174	1165	2.38	1.60
	4	0.234	135	2265	0.127	758	2.68	1.38
	6	0.148	133	2080	0.0730	402	2.26	1.37
	8	0.091	116	778	0.0157	216	1.97	1.27
	9	0.049	108	333	0.0040	139	2.36	1.41
	9¾	0.0	105	0	0.0	0	...	0
4 Orifice Vel. 1715 fpm Orifice Temp. 198 F Room Temp. 86 F	0	1.000	198	1383	0.329	1860	1.08	0.97
	2	0.392	155	2695	0.392	1690	2.51	1.50
	4	0.215	130	4015	0.338	1198	3.08	1.51
	6	0.154	127	5060	0.272	751	2.85	1.42
	8	0.119		3910	0.163	474	2.31	1.41
	10	0.079	121	2280	0.0559	297	2.21	1.26
	12¼	0.0	106	0	0.0	0	...	0.0

U_{Ave} = Average downward velocity of stream evaluated by dividing total volume rate of downward flow by area of stream.

U'_{Ave} = Average downward velocity of stream evaluated by dividing the total rate of flow of downward momentum by the corresponding mass rate of flow of stream air.

U_{Max} = Maximum downward velocity of stream at cross section specified.

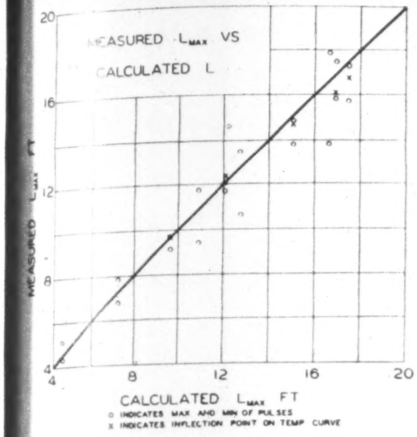


Fig. 10—Maximum downward blow 5.75 in. diam converging nozzle—measured values versus calculated values

ured. Air temperatures were measured by 22 gage copper-constantan thermocouples mounted near each Pitot tube. (See Fig. 12.)

The frame structure and the elevator were later replaced by a simple steel structure offering a minimum of interference to the flow of the stream. Improvements were also made in the instrument carriage to expedite the collection of data.

Test Procedure

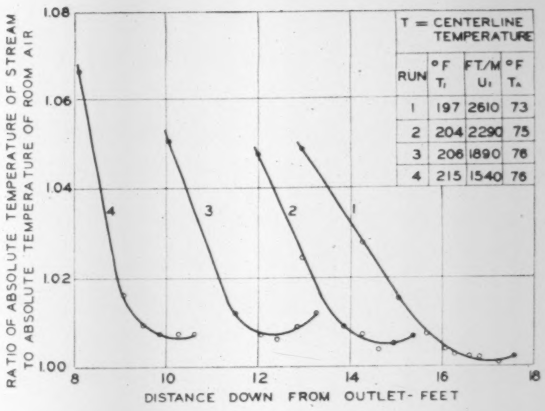
Preliminary tests were run to determine the ratio of the central velocity at the orifice to the average velocity at the orifice. Thereafter only the central velocity was measured to determine the average orifice velocity. In some of the tests with the converging nozzle a velometer and titanium tetrachloride ($TiCl_4$) smoke were used as auxiliary means for determining the bottom of the stream.

Horizontal temperature and velocity traverses were made at the centers of 3 in. squares over the entire cross section of the stream. A complete horizontal and vertical traverse took a full day and some difficulty was encountered in determining the maximum blow because the stream pulsated vertically at the bottom and for an appreciable distance up toward the orifice. Because of pulsations the bottom of the stream shifted vertically through a range of approximately 2 to 3 ft.

Summary

Data on the downward projection of heated air presumably may be

Fig. 11—Absolute temperature values at various distances down from outlet along the axis of the stream



T = CENTERLINE TEMPERATURE

RUN	°F T_1	FT/M U_1	°F T_A
1	197	2610	73
2	204	2290	75
3	206	1890	76
4	215	1540	76

correlated by means of two dimensionless factors. One of these is, $\frac{T_1 - T_a}{T_a}$ which is formed by dividing the difference between the absolute temperature of the stream at the orifice and that of the room air by the absolute temperature of the room air. The other is $\frac{U_1{}^2}{gD_1}$ which is formed by dividing the orifice velocity squared by the product of the acceleration of gravity and the diameter of the orifice. For correlating data on the maximum downward blow, a formula of the following form is tentatively suggested:

$$\frac{L_{\text{Max}}}{D_1} = \frac{1}{a_1}\left[a_3\left(\frac{1}{K}+1\right)^{1/2}-1\right] \qquad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$K = \left[\left(\frac{T_1}{T_a}-1\right)gD_1\right] \Big/ \left(a_2 U^2{}_{1\text{av}}\right) \qquad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where

a_1 = a factor dependent principally upon the rate and pattern of air entrainment per foot of stream travel.
a_2 = a factor dependent principally upon a_1 and the pattern of velocity distribution across a horizontal section of the stream.
a_3 = a factor dependent principally upon K and the point in the stream at which the entrainment of room air ceases.
$U_{1\text{av}}$ = average velocity of stream air leaving the orifice based on the volume rate of flow of the air, feet per second.
L_{Max} = maximum downward travel of stream, feet.
D_1 = diameter of orifice, feet.
T_1 = absolute temperature of air leaving orifice, degrees Fahrenheit.
T_a = absolute temperature of room air, Fahrenheit degrees.
g = acceleration of gravity, feet per (second) (second).

Equation 2 resolves into Equation 1, which was given in the early part of this paper, when a_3 is set equal to unity and a_2 is set equal to a_1. Equations 1 and 2 should be regarded as being subject to modification as the studies under way progress, particularly since they are based on the assumption that the downwardly moving stream will have no effect on the state of the ambient atmosphere.

The maximum downward travel of the streams studied formed a fairly consistent but not conclusive pattern when plotted against values of the maximum blow calculated by means of Equation 1. When a straight pipe 6.5 in. in diameter was used as the projecting nozzle, the maximum blow was somewhat larger than the calculated value. When a converging nozzle with a 5.75-in. orifice was used, the maximum blow was either in close agreement with the calculated value or somewhat smaller than this value.

Although the actual rate of room air entrainment per foot of stream travel may be a variable along the path of the stream, the studies made under Case 1 and Case 2 indicate that an average rate of entrainment, treated as a constant, may be used satisfactorily in deriving an equation for the maximum downward blow. This result, however, should be reviewed when dependable data have been obtained on the pattern of room air entrainment.

Acknowledgment

The authors are very grateful for the encouragement and assistance they have received from Prof. G. L. Tuve, C. M. Ashley, Ernest Szekely, and Dr. Gerald Pickett.

Appendix

Formulas for Case 1

Let:

D = diameter of stream, feet.
g = acceleration of gravity, feet per (second) (second).
L = stream travel down from orifice, feet.
M = mass rate of flow across horizontal section of stream, pounds per second.
T = temperature of stream air, Fahrenheit degrees absolute.
T_a = temperature of room air, Fahrenheit degrees absolute.
U_{av} = average downward velocity of stream at a horizontal section, based on volume flow, feet per second.
U_m = average downward velocity of stream at a horizontal section, based on momentum flow, feet per second.
U_x = lateral velocity of escape of stream air from bottom portion of stream, feet per second.
α = U_m/U_{av}, assumed to be unity for Case 1.
β = $\frac{U_x}{U_{av}}$ = ratio of lateral velocity of escape of stream air to velocity of stream at the level of escape, feet per second.
ρ_{av} = average density of stream air at a horizontal section, pounds per cubic foot.
θ = apex angle of cone drawn tangent to the stream boundary.

Subscript 1, designates values at the orifice.

Subscript i, designates values at the interface, *i.e.*, the plane between the divergent and convergent sections of the stream.

The equations under this heading are based on the assumption that the ratio of the average stream velocity based on momentum flow to that based on volume flow may be treated as constant and set equal to α. Otherwise the assumptions employed are the same as those outlined for Case 1 in the main body of the paper. When α is placed equal to unity, the equations reduce to those developed for Case 1.

A. Formulas for the portion of the stream over which room air is being entrained:

Slope of the stream boundary in the plane of the vertical axis of

$$\text{stream} = \text{Tan}\ \frac{\theta}{2} = \frac{1}{2} \bullet \frac{dD}{dL} =$$

$$\frac{\left(\frac{D}{M} \bullet \frac{dM}{dL}\right)\left[\left(\frac{M_1}{M}\right)\left(\frac{T_1}{T_a} - 1\right) + 2\right]}{4\left[\left(\frac{M_1}{M}\right)\left(\frac{T_1}{T_a} - 1\right) + 1\right]} + \frac{\left(\frac{M_1}{M}\right)\left(\frac{T_1}{T_a} - 1\right)}{4\left(\frac{\alpha U_{av}^2}{Dg}\right)} \quad \ldots\ldots (1a)$$

Ratio of stream diameter to diameter of orifice =

$$\frac{D}{D_i} = \left[1 + \left(\frac{T_a}{T_1}\right)\left(\frac{M}{M_1} - 1\right)\right]^{\frac{1}{2}} \left(\frac{U_{1av}}{U_{av}}\right)^{\frac{1}{2}} \quad \ldots\ldots (2a)$$

Rate of room air entrainment per orifice diameter per pound of orifice air, per foot of stream travel =

$$\frac{D_1}{M_1} \bullet \frac{dM}{dL} = a_1 \quad \ldots\ldots (3a)$$

Where

a_1, by assumption, is a constant.

Ratio of the mass rate of downward flow across any horizontal section of stream to the mass rate of flow of orifice air =

$$\frac{M}{M_1} = \frac{a_1 L}{D_1} + 1 \quad \ldots\ldots (4a)$$

Distance down from the orifice measured in orifice diameters, to the point at which the velocity of the stream has an average value, U_{av}, =

$$\frac{L}{D_1} = \frac{1}{a_1}\left[\frac{\left(\frac{\alpha\, a_1\, U_{1av}^2}{g\, D_1}\right) + \left(\frac{T_1}{T_a} - 1\right)}{\left(\frac{\alpha\, a_1\, U_{av}^2}{g\, D_1}\right) + \left(\frac{T_1}{T_a} - 1\right)}\right]^{\frac{1}{2}} - \frac{1}{a_1} \quad \ldots\ldots (5a)$$

Ratio of the average downward velocity of stream at any cross section to the average velocity of the stream at the orifice =

$$\frac{U_{av}}{U_{1av}} = \frac{1}{\frac{a_1 L}{D_1} + 1}\left[1 - \left(\frac{gD_1}{\alpha\, U_{1av}^2}\right)\left(\frac{T_1}{T_a} - 1\right)\left(\frac{L}{D_1}\right)\left(\frac{a_1 L}{D_1} + 2\right)\right]^{\frac{1}{2}} \quad \ldots\ldots (6a)$$

Note

$$\alpha = \frac{U_m}{U_{av}} = 1 \text{ for Case 1}$$

B. Formulas for the portion of the stream across the boundary of which stream air leaves the stream envelope.

Ratio of the lateral velocity of escape, U_x, to the average downward velocity of the stream at the level of escape, U_m =

$$\frac{U_x}{U_m} = \beta = \text{unity, for Case 1} \quad \ldots\ldots (7a)$$

$$\frac{D}{D_1} = 1.6\alpha^{\beta}\left(\frac{L_{max} - L}{D_1}\right) \quad \ldots\ldots (8a)$$

$$\frac{U_{av}}{U_{1av}} = \left[\left(\frac{1.25\ g\, D_1}{\alpha^2\, \beta\, U_{1av}^2}\right)\left(\frac{D}{D_1}\right)\left(\frac{T_1}{T_a} - 1\right)\right]^{\frac{1}{2}} \quad \ldots\ldots (9a)$$

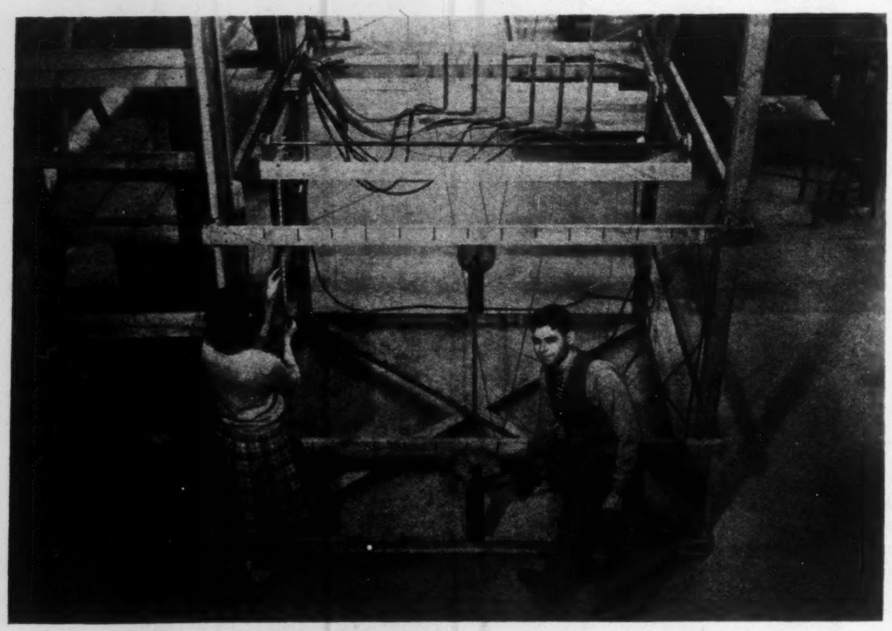


Fig. 12—Lower portion of experimental setup

C. Formulas for interface between convergent and divergent portions of stream.

$$\frac{U_{iav}}{U_{1av}} = \left(\frac{1.25\,a_1 K}{\beta\,\alpha}\right)^{0.4} \left[\frac{\left(\frac{U_{iav}}{U_{1av}}\right)^2 + K}{K+1}\right]^{0.1} \left(\frac{T_i}{T_1}\right)^{0.2} =$$

$$\text{approx.} \left(\frac{1.25\,a_1}{\beta\,\alpha}\right)^{0.4} \sqrt{K} \; \ldots\ldots (10a)$$

where,

$$K = \left(\frac{g\,D_1}{\alpha\,a_1 U_{1av}^2}\right)\left(\frac{T_1}{T_a} - 1\right) \ldots\ldots (11a)$$

$$\frac{L_{max} - L_i}{D_1} = \frac{\left(\frac{U_{iav}}{U_{1av}}\right)^2}{2a_1K}\left[\frac{1+K}{\left(\frac{U_{iav}}{U_{1av}}\right)^2 + K}\right]^{1/2}$$

$$\ldots\ldots\ldots\ldots\ldots\ldots (12a)$$

$$\frac{D_i}{D_1} = \left(\frac{L_{max} - L_i}{D_1}\right) 1.6\,\alpha\,\beta \;\ldots\ldots (13a)$$

$$\frac{T_i}{T_1} = \left[\frac{\left(\frac{U_{iav}}{U_{1av}}\right)^2 + K}{1+K}\right]^{1/2}\left(1 - \frac{T_a}{T_1}\right) + \frac{T_a}{T_1} \ldots\ldots\ldots\ldots\ldots\ldots (14a)$$

D. Formula for the maximum downward blow

$$\frac{L_{max}}{D_1} = \frac{1}{a_1}\left[a_3\left(\frac{1}{K} + 1\right)^{1/2} - 1\right]$$

$$\ldots\ldots\ldots\ldots\ldots\ldots (15a)$$

where,

$$a_3 = \frac{1 + \frac{\left(\frac{U_{iav}}{U_{1av}}\right)^2}{2K}}{\left[1 + \frac{\left(\frac{U_{iav}}{U_{1av}}\right)^2}{K}\right]^{1/2}}$$

J. F. TUTTLE RETIRES

J. F. Tuttle, Life Member of the ASHVE, retired on December 31, 1947 from the partnership of J. F. Tuttle Co., Boston, Mass.

The J. F. Tuttle Co., which will continue under the same name, is district representative for Warren Webster & Co., a firm with which Mr. Tuttle was associated for over 50 years in the various capacities of draftsman, inspector, sales engineer, chief of the heating and ventilating department, assistant manager, manager and sales agent. Among the other firms with which Mr. Tuttle has been connected for a number of years are the Kewanee Boiler Corp., and the Ric-wiL Co.

Mr. Tuttle joined the ASHVE in 1913 and was elected to Life Membership in 1943. He has been an active member of the Massachusetts Chapter for many years, serving as president in 1922.

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ELECTION OF JAMES CLOSE

The election of James W. Close to the position of general secretary and treasurer of the *Sheet Metal Workers International Association*, Washington, D. C., has been announced. Mr. Close, who held the position of president and business representative in his 25 years of service with the Chicago Sheet Metal Workers Union, Local 73, assumed his new duties on January 5. He is an active member of the ASHVE, having joined in 1944, and has been prominent in the affairs of the Society's Illinois Chapter.

ADMIRAL HUSSEY SUCCEEDS DR. AGNEW AS *ASA* SECRETARY

The *ASA* has announced the appointment of Vice-Admiral George Frederick Hussey, Jr., USN, retired, to succeed Dr. P. G. Agnew, who for the past 28 years has served the *American Standards Associations as* secretary and head of staff. Admiral Hussey officially took office as secretary on January 1, 1948.

Prior to his appointment with the *ASA*, Admiral Hussey won recognition from industry for his able administration as chief of the bureau of ordnance, U. S. Navy Department. For his meritorious service and forceful leadership in directing the design, production and supply of weapons while serving in this capacity, Admiral Hussey was awarded the Distinguished Service Medal by the United States Government.

Dr. Agnew will remain in the service of the *ASA* as consultant, where his broad knowledge of standardization will give valuable support to the work of the officers, the board of directors, and the staff.

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DONALD A. MacWATT APPOINTED MANAGER

Donald A. MacWatt, formerly sales engineer, Powers Regulator Co., New York, N. Y., has been appointed manager of the New York branch. Mr. MacWatt has been a member of the Society for 10 years and is a member of the New York Chapter.

A graduate of Stevens Institute of Technology, Mr. MacWatt received his mechanical engineering degree in 1928. One of his first positions was with Marc Eidlitz and Sons, Inc., New York, N. Y., where he held the position of mechanical engineer. Prior to joining the staff of the Powers Regulator Co., Mr. MacWatt was associated with the National Regulator Co., also in New York, as a sales engineer.

◆

J. E. McDONNELL, 40, DIES

The Society has learned with regret of the passing of John Edward McDonnell, sales engineer of McDonnell & Miller and prominent Chicago member of the ASHVE, who died suddenly on January 27, 1948.

A native of Des Moines, Iowa, Mr. McDonnell was born on August 9, 1907. He attended Roosevelt High School, Des Moines, preparatory to entering Iowa University. One of his first positions was as a member of the *Heating and Ventilating* magazine staff. In 1929, he joined the Fulton Sylphon Co., as a sales representative. He became associated with the McDonnell & Miller Co., in 1930, serving as vice president and sales engineer. Because of his wide acquaintance in the heating field, his legion of friends will regret his untimely passing.

The Officers and Council of the American Society of Heating and Ventilating Engineers extend their deepest sympathy to his widow and family who survive and to their fellow Council member E. N. McDonnell who suffers an irreparable loss.

*Summary of Local Chapter Meetings**

Atlanta—January 8, 1948. Subject: The Latest Developments in Guided Missiles and Supersonic Aircraft. Speaker: Allen Pope, aeronautics department of Georgia Tech. Mr. Pope's talk proved very interesting and instructive. Other Features: Spencer Boyd gave a report on the status of the codes committee, J. J. O'Shea reported for the program committee and the treasurer gave a report on chapter finances. H. King McCain, past president of the chapter, reported on the reservations for a special car to the 54th Annual Meeting. Attendance 33. Attendance ratio 0.27.

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Central Ohio—December 15, 1947. Subject: Automatic Stokers. Speaker: S. H. Beach, Iron Fireman Co. Mr. Beach discussed stokers in the automatic heating field in an interesting and authoritative manner. Other Features: H. R. Allonier was elected delegate and W. M. Myler, Jr. alternate to the 54th Annual Meeting in New York. Prof. A. I. Brown reported on the Heat Loss Calculation's Committee meeting in Cleveland and briefly discussed basement losses and outdoor design temperatures. Attendance 37.

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Cincinnati—December 2, 1947. Subject: Discussion on Industrial Dust Control. Speaker: J. M. Kane, chief engineer, Industrial Dust Control Division, American Air Filter Co., Louisville, Ky. That Mr. Kane's talk was interesting to the members was demonstrated in the lengthy discussion period which followed. Other Features: Reports were given by the chairmen of the membership, meetings and entertainment committees. After an invitation from the New York Chapter was read, a discussion was held regarding the possibility of reserving a private car to the 54th Annual Meeting in New York. Attendance 48.

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Connecticut—January 12, 1948. Subject: Problems in Connection with Maritime Work. Speaker: Professor Herbert L. Seward, Yale University. After an interesting discussion of problems in connection with maritime work, a motion picture of the sinking of the Normandie and the salvage of this ship was shown. Other Features: Walter E. Heibel, chairman of the Committee on Arrangements for the 54th Annual Meeting, announced some of the plans which have been made for this meeting. Attendance 56. Attendance ratio 0.3.

•

Delta—January 8, 1948. Subject: Forum on Are We Pricing Ourselves Out of the Market? Moderator: G. E. May, New Orleans Public Service, Inc., New Orleans, La. Mr. May stated that the purpose of the open forum was to discuss and review the recent trends in equipment and labor costs in relation to the supply of finished materials and the demand for air conditioning service. Everyone in attendance joined in the discussion, the subject of which ranged from the price of air conditioning equipment in New Orleans to the cost of potatoes in Europe. This meeting was held in conjunction with the Annual Meeting of the Louisiana Engineering Society. Attendance 14.

•

Iowa—January 13, 1948. Subject: Refrigeration Components. Speaker: L. L. Arbuckle, Bell and Gossett Co., Chicago, Ill. In his interesting talk Mr. Arbuckle spoke about the effect of the fouling factor in determining proper size of heat exchanger equipment and the effect of this factor on exchangers with plain or finned tubes. The requirements of the Hartford Inspectors and the *ASME* were also mentioned. Other Features: A motion was carried that a committee be appointed to work with the Iowa State College in planning a heating and air conditioning conference to be held at the College, March 22-25. Attendance 26.

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Kansas City—January 5, 1948. Subject: Controls for Heating and Cooling Installations. Speaker: J. R. Vernon, sales promotion manager, Johnson Service Co., Milwaukee, Wis. Mr. Vernon prefaced his discussion on controls with a few comments on the National Society, which included the ever increasing membership and the extensive research program. A discussion of the physiological aspects of heating and cooling and an outline of the basic controls and their classifications followed. Among the other points discussed were humidity instruments, the master and sub-master thermostatic control system, and valves and valve bodies. This excellent presentation was enjoyed by all. Attendance 68.

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Manitoba—January 15, 1948. Subject: Indoor-Outdoor Control

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*Note: The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

Speaker: John F. Bertram, district manager, Minneapolis-Honeywell Regulator Co., Ltd., Winnipeg, Manitoba, Canada. Mr. Bertram discussed the different types of outdoor anticipating thermostats and their various applications, limitations, and advantages. In concluding, Mr. Bertram called for questions on the subject and all members took part in an active and interesting discussion. Other Features: Fred Taylor of the Canadian Chapter, *National Warm Air Heating and Air Conditioning Association* spoke on the program of dealer schools currently being held throughout Canada and the United States and the advisability of continuing this valuable training in both the warm air and hot water industries. Mr. Taylor brought a message of good will from the Ontario Chapter of the ASHVE, of which he is also a member. It was announced that William Glass had been appointed chapter delegate, in place of D. S. Swain, delegate, and E. Anderson, alternate, who are unable to attend the 54th Annual Meeting. Plans were made for the annual winter party. Attendance 14.

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MEMPHIS—November 17, 1947. Subject: Foamglas Insulation. Speaker: Orrin Howard, Armstrong Cork Co. Mr. Howard's illustrated talk was ably presented. Other Features: Art Theobald showed some very fine slides taken at the Semi-Annual Meeting of the Society. Members of the committee which will nominate 1948 officers for the Chapter were elected. Attendance 23. Attendance ratio 0.52.

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MICHIGAN—January 12, 1948. Subject: Some Recent Japanese Experiences. Speaker: R. M. Van Duzer, operating engineer of power plants, The Detroit Edison Co., Detroit, Mich. Mr. Van Duzer, a member of a government commission which had been requested by General MacArthur to survey Japan's power facilities, recounted some of his experiences in that country. Members found this topic highly interesting and informative. Other Features: The central heating department of The Detroit Edison Co. was host to the Michigan Chapter for a meeting which has become an annual event. Groups of members and their guests were escorted through the boiler room and the turbine room of the company's Delray power plant. Later, the groups assembled in the auditorium where some interesting movie shorts were shown. All official business was postponed until the next meeting. Attendance 240.

•

MINNESOTA—January 12, 1948. Joint Meeting with the Twin City Section, *American Society of Refrigerating Engineers*. Subject: Development of Atomic Power. Speaker: Dr. A. O. Nier, professor of physics, University of Minnesota. Dr. Nier, internationally famous as a pioneer in research leading to the separation of Uranium 235, presented many interesting details covering the problems and progress of atomic energy development. The interest of the engineers present in this topic was demonstrated in the discussion period which followed. Other Features: The entertainment committee of the *ASRE* presented a movie short on the University of Minnesota's football team highlights for the 1947 season which was enjoyed by all present. Attendance 156.

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MONTREAL—January 5, 1948. Subject: Powdered Milk Industry. Speaker: Professor Pierre Paul Vinet, Ecole Polytechnique de Montreal. The entire design of a milk plant in Granby, on which he had acted as a consulting engineer, was traced by Professor Vinet. Other Features: A one minute silence was held for the late James Way, a member of the Montreal Chapter for many years. Attendance 43.

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NEBRASKA—December 9, 1947. Subject: Experiences in India. Speaker: Frank E. Prawl, manager and chief engineer, Sidles Co., air conditioning div., Omaha, Nebr. As a part of his interesting talk, Mr. Prawl showed pictures of a seven ton refrigeration unit which was erected in India by a few of his men and himself while he was in the service. Since they were not able to get any new equipment, the entire installation was built with old automobile parts and old pipe. Mr. Prawl also showed movies of big game hunting. Attendance 31.

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OKLAHOMA—January 15, 1948. Subject: Engineered Air Distribution. Speaker: V. M. Lathers, sales engineer, Barber-Colman Co., Rockford, Ill. Mr. Lathers gave an excellent presentation and a lively discussion period followed. Other Features: Reports were given by the chairman of the program committee and by the treasurer. G. T. Donceel was appointed delegate to the 54th Annual Meeting, while E. T. P. Ellingson was appointed alternate delegate. Attendance 43. Attendance ratio 0.93.

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ONTARIO—January 26, 1948. Subject: Technology Tomorrow. Speaker: Dr. Baldwin M. Woods, president of the ASHVE and director, university extension, University of California, Berkeley, Calif. Dr. Woods' address was very enthusiastically received and President Stott thanked Dr. Woods on behalf of the chapter. Other Features: Norton Kingsland and H. A. Baxter reported on arrangements for the 54th Annual Meeting. Attendance 71. Attendance ratio 0.38.

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ONTARIO—January 5, 1948. Subject: Why Panel Heating? Speaker: C. D. Niven, National Research Laboratories, Ottawa. An interesting discussion period followed Dr. Niven's talk. Other Features: Norton Kingsland, chairman of the On-to-New York Committee, reported on the progress of plans for members of the Ontario Chapter to attend the Annual Meeting in New York. He stated that approximately 60 members of the chapter will attend the meeting. Attendance 112. Attendance ratio 0.6.

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Pacific Northwest—November 18, 1947. Subject: Heating and Ventilating of Airplanes. Speaker: R. L. Linforth, engineering dept., Boeing Aircraft Corp. Mr. Linforth discussed the problems involved in heating and ventilating an airplane and how the human body reacts to adverse conditions during flight operations, stressing the importance of proper heating, ventilating and pressurization. Other Features: Mr. Kistler of the Puget Sound Engineering Council briefly outlined the facts pertaining to the status of the professional engineers licensing law and the various petitions before this board. G. W. May explained the Council's work in connection with the present licensing law and Prof. E. O. Eastwood discussed the original concept of this law. Attendance 33.

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Pittsburgh—January 12, 1948. Subject: Inspection of Dravo Corp., Neville Island plant. Among the members of the Dravo Corp. staff introduced by Robert Berg, who acted as chairman of the meeting, were W. Fitch, chairman of the board, and R. M. Rush. The building and operation of a space heater were discussed by Mr. Rush. Captain Thomas Green, owner of the *Delta Queen*, was introduced, and he discussed the boat generally, from the time it was built until the present. Members greatly enjoyed the talks and the inspection trip through the plant. Other Features: Reports for the different committees were given, and T. F. Rockwell asked that action be taken by the chapter against the proposed amendments to the Society Constitution. Attendance 104. Attendance ratio 0.57.

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Rocky Mountain—January 7, 1948. Subject: Eliminating Hazards of Industrial Toxic Agents. Speaker: Franklin W. Church, chief, section of industrial hygiene and toxicology, University of Colorado. Mr. Church discussed the problems encountered in the elimination of the hazards of toxic agents in industrial processes. Instruments used in the sampling of the air and the analysis of various agents were demonstrated. Members enjoyed Mr. Church's presentation together with the conducted tour of the University of Colorado Laboratory where various research projects on cadmium and lead poisoning and the treatment of advanced silicosis were explained. Attendance 37.

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St. Louis—January 6, 1948. Subject: Controls for Winter and Summer Air Conditioning in Industrial and Public Building Installations. Speaker: J. R. Vernon, sales promotion manager, Johnson Service Co., Milwaukee, Wis. Mr. Vernon explained the classification of controls, the various possible materials which could be used in the construction of thermostats and hygrostats, and the application of various valves to different types of air conditioning systems. Slides were used to illustrate this interesting presentation. Attendance 79.

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South Texas—January 20, 1948, Subject: Technology Tomorrow. Speaker: Dr. Baldwin M. Woods, national president of the ASHVE, and director, university extension, University of California, Berkeley, Calif. Dr. Woods reviewed modern day inventions that are the outgrowths of World War I and World War II. In tracing the growth of the air conditioning industry, one of the nation's largest and fastest growing enterprises, Dr. Woods stated that air conditioning was an outgrowth of people's desire for easy living and the strong urge for comfort and convenience. Other Features: Wayne Long of the Texas A. & M. College, announced that as the result of the contributions from the South Texas Chapter, North Texas Chapter, the San Antonio Chapter, and the Texas A. & M. Student Branch, three members from the Texas A. & M. Student body were selected to attend the 54th Annual Meeting. Attendance 146.

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Southern California—January 21, 1948. Subject: Air Pollution Control. Speaker: Dr. L. C. McCabe, director, Los Angeles County air pollution control district. Dr. McCabe pointed out some common sources of air pollution such as lumber yard incinerators, chemical plants, oil refineries and backyard rubbish burners. The temperature inversion condition peculiar to the local area, which at times holds the smoke and fumes down preventing their escape into the upper air, was also described by Dr. McCabe. Other Features: After Arthur Hess reported on plans for a proposed Los Angeles Technical Council, he was appointed delegate to serve on this Council and Maurice Greiner was appointed alternate. Attendance 70.

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Utah—January 14, 1948. Subject: The Liquefaction of Coal. Speaker: C. J. Christensen, dean of the mines and metal school, University of Utah. Dr. Christensen discussed the present known supplies of solid, liquid and gaseous fuels, stressing the fact that the present reserves of oil and gas fuel are low and that anticipated demands are greater than the existing supply. Because of this shortage, the government and industry are particularly interested in research in the field of the liquefaction of coal. Dr. Christensen in concluding his informative discussion stated that Utah, Colorado, and Wyoming, as the nation's largest bituminous coal centers, will become the site of many new industries. Other Features: President Gritton reminded those present of the 54th Annual Meeting in New York and several members signified their intention of attending this meeting. Attendance 34. Attendance ratio 0.51.

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Utah—December 11, 1947. Subject: Reverse Cycle Refrigeration or the Heat Pump. Speaker: J.

Donald Kroeker, consulting engineer, Portland, Ore. Before beginning his talk, Mr. Kroeker gave an informal review of some of the projects sponsored by the Oregon Chapter of the ASHVE. In his discussion of reverse cycle refrigeration he described the various materials that could be used as sources of heat. An interesting series of slides was shown of a reverse cycle plant, using well water, which had been designed by Mr. Kroeker and his associates. Views of the compressors and pumps, as well as of the piping and duct work in detail, led to a very interesting discussion period. Attendance 27. Attendance ratio 0.37.

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WASHINGTON, D. C.—January 14, 1948. Subject: Oil from Coal. Speaker: Joseph D. Doherty, assistant chief, synthetic fuels division, Bureau of Mines. Mr. Doherty stated that the development of synthetic oil, using coal as a source, is thought to be the most promising method of relieving the current oil shortage. At least half of Germany's high-octane gasoline produced during the war was derived from coal, using either the direct or indirect process of extraction. Other Features: F. J. Pratt reported on a proposed engineers licensing law which has been referred to Congress. Members of the Washington Chapter were invited to attend a joint meeting of the *ASRE* Baltimore and Wilmington Chapters, and it was announced that a joint meeting of the *ASRE* and ASHVE chapters in the Washington area would be held in February. Attendance 58.

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WASHINGTON, D. C.—December 10, 1947. Subject: Heating Methods in England. Speaker: Robert K. Thulman, chief mechanical engineer, Federal Housing Administration, Washington D. C. Mr. Thulman discussed his experiences on two recent trips to England, which were made at the request of that country to study British heating methods and to make recommendations for fuel conservation. Other Features: President Hill called attention to the fact that several former presidents of the chapter, F. A. Leser, S. L. Gregg and L. Bert Nye, had recently been elected officers of the Engineers' Club of Washington. S. Capvasco, a Chilean air conditioning contractor on an extended visit to this country, was introduced by President Hill, and spoke on some of his experiences since coming to this country. Attendance 48.

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WESTERN MICHIGAN—December 8, 1947. Subject: Radiant and Panel Heating. Speaker: Harold A. Lockhart, chief engineer, Bell & Gossett Co., Morton Grove, Ill. Mr. Lockhart reviewed the history of radiant heating and pointed out the necessity for more accurate data for design purposes. He also stated that where ventilation or humidity control is necessary, these systems must be installed in addition to the radiant heating system. Other Features: W. W. Bradfield, Sr., one of the founders of the Western Michigan Chapter and the oldest member of the chapter, was honored with a gift of his favorite cigars as a token of respect. Attendance 139.

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WISCONSIN—January 19, 1948. Subject: Condensation in Buildings. Speaker: Richard S. Dill, chief, heat transfer section, National Bureau of Standards, Washington, D. C. Mr. Dill reviewed the history of thermoconductivity and used slides to demonstrate the test apparatus used by the Bureau of Standards to obtain heat transfer coefficients. In describing the various common problems connected with condensation in buildings Mr. Dill illustrated with slides the test apparatus for checking insulation and vapor barriers. Other Features: W. A. Ouweneel, chairman of the program committee reported on the programs for the balance of the season. Carl H. Amundson of the membership committee announced plans for interesting engineers, who belong to the National Society but are not affiliated with the local chapter, to become members. Members were advised that the publication *Milwaukee Engineering* would try to print technical articles in addition to publishing meeting announcements of the various societies and that any member interested in contributing should notify B. M. Kluge, chapter secretary and ASHVE section editor, *Milwaukee Engineering*. Attendance 55.

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WISCONSIN—December 15, 1947. Subject: Boiler Water Conditioning for Low and Medium Pressure Boilers. Speaker: E. P. Fager, vice president and chief chemical engineer, Dearborn Corp., Chicago, Ill. Mr. Fager indicated the two basic forms of corrosion which give the engineer difficulty in boiler operation and described the various treatments which can be applied to prevent this corrosion, pointing out that large boiler plants are better equipped to handle this problem than smaller plants. Corrosion in air washing and cooling water systems and possible treatments for this type of corrosion were also discussed by Mr. Fager. A lively discussion period followed and the meeting was closed with a rising vote of thanks to the speaker. Attendance 28.

Student Branch

TEXAS A. & M.—January 15, 1948. Subject: An Engineer in the Steamfitting Trade. Speaker: H. Martin, Jr., Martin Brothers, Dallas, Tex. A discussion followed this interesting talk in which H. Martin, Sr., participated. Other Features: W. E. Long spoke on the donations received from the other Texas Chapters and from the Student Branch, toward the traveling expenses of student delegates to the 54th Annual Meeting. Officers for the coming season were elected as follows: S. E. Ammons, *president*, T. V. Burns, *vice president*, C. P. Howard, *secretary-treasurer*, and Siegmund Goldman, *reporter*. Attendance 31.

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TEXAS A. & M.—December 18, 1947. G. H. Jackson, S. E. Ammons and

T. V. Burns were elected delegates to the 54th Annual Meeting in New York, while R. F. Phillips and C. P. Howard were elected alternates. A motion was carried that the Chapter express its gratitude in letters to the North, South and Southwest Texas Chapters, whose donations made it possible to send delegates to the Annual Meeting. G. F. Rhine of the Southwest Texas Chapter spoke briefly on the 54th Annual Meeting in New York. Attendance 28.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When the replies are received from references, the candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 109 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by March 25, 1948, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

ABRAHAMSON, KENNETH M., Sales Estimator & Designer, Jos. F. Palen, Inc. PROPOSERS: J. A. Craig, William Sturm. SECONDERS: F. H. Schneeberg, H. K. Heikkinen.

BAMFORD, ROBERT M., Partner, H. M. Bamford. PROPOSERS: A. C. Bartlett, L. G. Huggins. SECONDERS: R. L. Lincoln, F. C. Jones, Jr.

BASTIAN, V. F., Mech. Draftsman, Toltz King & Day, Inc. PROPOSERS: O. L. Lilja, R. W. Otto. SECONDERS: F. H. Schneeberg, William Sturm.

BENNETT, DONALD F., Mgr., Radiation & Unit Heater Sales, Warren Webster & Co. PROPOSERS: H. B. Hedges, A. J. Nesbitt. SECONDERS: John McElgin, J. O. Kirkbride.

BENNETT, L. M., Mech. Engr., John H. Ross. PROPOSERS: J. H. Ross, W. J. Usher, Jr. SECONDERS: D. A. Stott, H. R. Roth.

BREINHOLT, HARDEN W., Owner, H. W. Breinholt Co. PROPOSERS: A. R. Curtis, E. V. Gritton. SECONDERS: C. E. Ferguson, J. L. Ashton.

CAUVEL, H. L., Draftsman-Designer, Reg F. Taylor. PROPOSERS: H. L. De Vines, R. F. Taylor. SECONDERS: R. J. Salinger, Robert Kriechbaum

CHAPMAN, H. G., JR., Student, David Ranken Jr. School of Mechanical Trades. PROPOSERS: J. T. Lynch, G. B. Rodenheiser. SECONDERS: G. A. Langenberg, E. T. Clucas.

DAVIS, FRED H., Owner. PROPOSERS: S. M. Quackenbush, J. H. Bryce. SECONDERS: G. E. Adema, H. Seelbach, Jr.

DOBRIN, RUSSELL L., Mech. Engr., The Osborn Engineering Co. PROPOSERS: J. J. La Salvia, E. F. Morse. SECONDERS: Philip Cohen, J. C. Reynolds.

DUCKETT, ALBERT A., Owner, A. A. Duckett, Inc. PROPOSERS: R. H. Smiles, E. H. Dafter. SECONDERS: L. M. Church, M. E. Barnard.

ELLENBERGER, F. R., Section Head Design Engr., General Electric Co. PROPOSERS: W. E. Johnson, D. W. McLenegan. SECONDERS: F. H. Faust, W. L. Knaus*.

FENSTERMAKER, WARD R., Sales Engr., John J. Nesbitt, Inc. PROPOSERS: S. E. Fenstermaker, Jr., C. H. Hagedon. SECONDERS: G. B. Supple, G. O. Jackson. *(Advancement)*

FINUF, MARION W., Refrig. & Air Cond. Instructor, The Shreveport Trade School. PROPOSERS: E. J. Kearby, Wm. E. Fitzgerald. SECONDERS: R. M. Hood, B. E. Segall, Jr.

FITZGERALD, JOHN J., Htg. & Vtg. Engr., Scovill Mfg. Co. PROPOSERS: L. O. R. Clark, W. A. Johnson. SECONDERS: R. C. Atherton, P. D. Bemis.

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JOHNSON, THOMAS V., Assoc. Editor, Heating, Piping & Air Conditioning. PROPOSERS: G. G. Freyder, M. J. Ramond SECONDERS: C. M. Burnam, Jr., C. E. Price.

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* Non-Member

KARIBO, RICHARD J., Student, David Ranken Jr. School of Mechanical Trades. PROPOSERS: J. T. Lynch, G. B. Rodenheiser. SECONDERS: G. A. Langenberg, E. T. Clucas.

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SCHULZ, ROBERT H., Sales Repr., Minneapolis-Honeywell Regulator Co. PROPOSERS: G. B. Richmond, J. B. Lammons. SECONDERS: N. C. Ledbetter, J. D. Flinn.

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SMITH, THOMAS L., JR., Student, Washington University. PROPOSERS: A. R. Burgess*, R. R. Tucker*. SECONDERS: F. A. Lockwood*, J. H. Carter.

SNELLER, ALBERT J., Sales Engr., Covert Engineering Co. PROPOSERS: S. C. McCann, E. E. Ralston. SECONDERS: D. M. Allen, W. K. Dyer.

SODERBERG, CURTIS H., Dist. Mgr., Perfex Corp. PROPOSERS: T. H. Smoot, R. C. Malvin. SECONDERS: P. B. Holmes, L. B. Miller.

SPANGENBERG, THEODORE E., Vice Pres., Pelican Equipment & Appliance Co., Inc. PROPOSERS: E. J. Kearby, W. E. Fitzgerald. SECONDERS: A. H. Otto, R. M. Hood.

STURGELL, JAMES W., Student, David Ranken Jr. School of Mechanical Trades. PROPOSERS: J. T. Lynch, G. B. Rodenheiser. SECONDERS: G. A. Langenberg, E. T. Clucas.

Taylor, Eric L., Tech. Asst., London County Council. **Proposers:** James Cunningham*, E. J. Tickner*. **Seconders:** I. R. Mackechnie*, J. C. Henly*. *(Advancement)*

Tempel, Walter W., Mgr., Arditi, Ltd., Refrigeration Dept. **Proposers:** R. B. Caughman, K. L. Crapeau*. **Seconders:** C. R. Beltz*, E. A. Mishler*.

Urrutia, Wilson C., Vent. & Air Cond. Draftsman, N. N. S. & D. D. Co. **Proposers:** G. F. Bertrand, B. F. Greenberg. **Seconders:** D. E. Phillips, P. C. Hartman, Jr.

Vaillancourt, J. A. Donat, Owner, J. A. Vaillancourt Reg'd. **Proposers:** Leo Garneau, F. A. Hamlet. **Seconders:** F. G. Phipps, S. W. Salter.

Van Ravenswaay, Robert C., Student, Massachusetts Institute of Technology. **Proposers:** A. L. Hesselschwerdt, Jr., James Holt. **Seconders:** D. A. Mooney*, W. W. Edwards*.

Vinet, Pierre P., Director, Dept. of Mech. Engrg. of Montreal. **Proposers:** Leo Garneau, F. A. Hamlet. **Seconders:** F. G. Phipps, S. W. Salter.

Wells, Robert L., Sales Engr., Marshall & Wells Co. **Proposers:** T. D. Stafford, O. D. Marshall. **Seconders:** R. B. Smith, H. D. Burtis.

Werner, George C., Chief Engr., J. Varming & Partners. **Proposers:** Jorgen Varming, Poul Demandt*. **Seconders:** Ole Skaerbo*, J. K. Christiansen*.

Wheeler, William R., Mech. Engr., Wm. C. Feige, **Proposers:** W. P. Flanigan, E. H. Taze. **Seconders:** F. Leser, G. B. Priester.

Wheller, Harry S., Jr., Prod. & Cost Control Eng L. J. Wing Mfg. Co. **Proposers:** H. S. Wheller, C. H. Smith. **Seconders:** T. R. Peyrek, E. J. Ritchie.

Wiggins, William D., Sales Tech., United States Radiator Corp. **Proposers:** M. C. Beman, E. H. Cox. **Seconders:** B. C. Candee, F. J. Bardo, Jr.

Zivi, Samuel M., Design Engr., General Installation Co. **Proposers:** Lester Gross, G. B. Pattiz. **Seconders:** E. T. Lucas, G. A. Langenberg.

The following candidates are students of North Carolina State College of Agriculture & Engineering. They are **Proposed** by L. L. **Vaughan** and R. B. **Rice**, and **Seconded** by K. P. **Hanson*** and N. W. **Conner***:

Agnew, Robert G.
Alexander, John B.
Arey, Herbert L.
Autry, Von, Jr.
Beaman, Bruce E.
Bean, Richard F.
Berman, Ralph I.
Carpenter, T. B.
Cooper, William B.
Garrison, T. R.
Griffing, Melvin E.
Hunter, Herbert N.
Jones, Clinton E.
Lefler, Deward F.
Lodor, James C.
Marshall, John G.
Morrison, E. B.
Powell, H. W. Jr.
Power, Thomas H.
Rumple, W. G. Jr.
Russell, R. W. Jr.
Seid, Joseph
Smith, James T.
Whitfield, H. A., Jr.
Wilkinson, W. A. Jr.
Willis, Thomas G.

Candidates Elected

In the past issues of the **Journal** of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by **Art. B-III**, *Section* 8, of the By-Laws, the following list of candidates elected:

Members

Caldwell, William C., Sales Mgr., Sheldons, Ltd., Galt, Ont., Canada.

Campbell, Roger P., Mgr., Sec'y.-Treas., E. K. Campbell Heating Co., Kansas City, Mo. *(Advancement)*

Carnahan, John H., Chief Mech. Engr., Coston & Frankfurt, Oklahoma City, Okla. *(Advancement)*

Collins, Desmond M., Bldg. Serv. Engr., Stone & Webster Engrg. Corp., Boston, Mass.

Crocker, Charles G., Engr., United Gas Corp., Houston, Tex.

Degler, Howard E., The Marley Co., Kansas City, Kans. *(Reinstatement)*

Fine, Maurice E., Mech. Engr., Harold N. Hermann & Associates, Inc., Cincinnati, Ohio.

Flanigan, William P., Vice Pres., Lloyd E. Mitchell, Inc., Baltimore, Md. *(Advancement)*

Gendeim, Sigman, Mfrs. Repr., Sigman Gendeim, Minneapolis, Minn.

Glaser, Harry D., Engr. & Sec'y., Henry Adams, Inc., Baltimore, Md. *(Advancement)*

Gowdy, Allen C., Mgr. & Engr., The Huffman-Wolfe Co., Atlanta, Ga. *(Advancement)*

Peters, Brice C., Pres., The Schape Mfg. Co., Inc., Baltimore, Md.

Reed, A. George, Plant Engr., The Gurney Foundry Co., Ltd., Toronto, Ont., Canada. *(Advancement)*

Rottmann, Paul O., Cons. Engr., Paul O. Rottmann, Shreveport, La.

Sibert, Alexander, Design Engr., A. E. Barker, Johannesburg, South Africa.

Sommerfield, Sumner S., Mech. Engr., Kroeschell Engineering Co., Chicago, Ill. *(Advancement)*

Theorell, Axel T., Civil Engr. & Dir., Hugo Theorells Ingeniorsbyra A/B, Stockholm, Sweden. *(Reinstatement)*

Associate Members

Baker, John T., Engr., Magney, Tusler & Setter, Minneapolis, Minn.

Baldwin, Ralph T., Treas., E. C. Powers & Son, Inc., Philadelphia, Pa.

Bobst, Earl F., Sales, American Radiator & Standard Sanitary Corp., Columbus, Ohio.

Bowles, John R., Sales Engr., Cia Ind. e Com. Glossop, Sao Paulo, Brazil.

Brown, Clinton H., Sales Engr., Desco Corp., Wilmington, Del.

Chauvin, Jean-Paul, Mgr., Sorel Mill & Builders Supply, Ltd., Sorel, P. Q., Canada.

Clarke, William L., Repr., T. L. Osberger Co., Grand Rapids, Mich.

Coddington, Dwight A., Specification Writer, The Coddington Co., San Francisco, Calif.

Crowe, Robert H., Sales, N. O. Nelson Co., Houston, Tex.

Finnell, Edgar C., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

FRANKLIN, JOHN K., Htg. Engr., McCrea Equipment Co., Washington, D. C.

GINGRAS, GILLES C. J., Design, Canadian Pacific Railways, Montreal, Que., Canada.
GRAU, EARL R., Engr., E. G. Snyder Co., Inc., Rochester, N. Y. *(Reinstatement)*

HENDRIX, WILLIAM T., Member of Firm, Wolf & Hahn, Allentown, Pa.

JENNER, JOHN W., Pres. & Mgr., Shelley Electric Co., Wichita, Kans.

LILLY, FRANK J., Mgr., Janitrol Triple Service Sales, Surface Combustion Corp., Columbus, Ohio.
LITWACK, HERMAN E., Anderson & Litwack, Chicago, Ill.

MATHIS, LUTHER N., L. N. Mathis Heating & Air Conditioning Co., San Antonio, Tex.
MCCULLOUGH, GOODALL W., Sales Engr., Electronic Supply & Engineering Co., Houston, Tex.
MCLACHLAN, JAMES, Plant Staff Asst., The Pacific Telephone & Telegraph Co., San Francisco, Calif.
MIXON, RALPH A., Sales Engr., Minneapolis-Honeywell Regulator Co., Dallas, Tex.
MONTGOMERY, FOSTER W., Sales, J. A. Walsh & Co., Houston, Tex.
MORRISON, ALAN MCK., Sales Mgr., Wisconsin Aireunits Corp., Milwaukee, Wis.
MURRAY, ROBERT P., East Ohio Gas Co., Akron, Ohio.

NELLIGANN, GILBERT, Sales Engr., Fitzgibbons Boiler Co., New York, N. Y.
NORRIS, CAMDEN G., Partner, Dill & Norris Sheet Metal & Heating Co., Columbus, Miss.
NUTTING, ROBERT E., Supt., Jaden & Dutton-Lainson Mfg. Companies, Hastings, Nebr.

POSTHUMA, J., Engr., Air Conditioning & Engineering Co., Ltd., Johannesburg, Transvaal, South Africa.

RIGBY, EDWARD D., Owner, E. D. Rigby Co., Portland, Ore.
ROBERTSON, STANLEY F., Engr., Anderson & Rowe, San Francisco, Calif.

SHIFFLETTE, DONALD F., Gen. Mgr., Stoker Sales & Service of Columbus, Inc., Columbus, Ohio.
SMITH, STELLE, JR., Pres., Stellco, Inc., Minneapolis, Minn.
SPRAGUE, KENNETH T., Dist. Repr., Bell & Gossett Co., Morton Grove, Ill.
SULLIVAN, RICHARD P., Application Engr., Westinghouse Electric Corp., Boston, Mass.

TALBOT, JOSEPH M., Engr., The Reed Co., Beaumont, Tex.
TURNBULL, ERNEST R., Design, Karel R. Rybka, Toronto, Ont., Canada.

WARNER, CLARENCE A., Serv. Mgr., General Oil Co., Inc., Medford, Mass.
WERWATH, CARL O., Vice Pres., Milwaukee School of Engineering, Milwaukee, Wis.
WILCOX, LELAND J., Dvlpt. Engr., Surface Combustion Corp., Columbus, Ohio.

ZIMMERMAN, RICHARD F., Mgr., & Owner, R. F. Zimmerman & Co., Shreveport, La.

Junior Members

ANTHONY, WILLIAM R., Gen. Supt., Anthony Co., Lubbock, Tex.

BLOJ, CARLOS, Engrg. Management, Sociedad Industrial Electer, Santiago, Chile.

CLAY, WILTON L., Sales Engr., Gulf Engrg. Co. New Orleans, La.
CODDINGTON, BERT A., Draftsman, Coddington Co., San Francisco, Calif.

DOLL, ERROL V., Engrg. Draftsman, The Austin Co., Oakland, Calif.
DULL, WILLIAM M., Htg. Engr., The Detroit Edison Co., Detroit, Mich.

GOLDMAN, REUBEN J., Engr., Reg F. Taylor, Houston, Tex.

HATTIS, BERNARD S., Partner, Robert E. Hattis, Cons. Engrs., Chicago, Ill.
HOROWITZ, SAUL, Plbg. & Htg. Design, H. Horowitz, Inc., Jersey City, N. J.
HURLBURT, RAYMOND G., Htg. Engr., Nelson Company, Detroit, Mich.

KELLY, ELBERT E., Mech. Engr., J. Donald Kroeker, Portland, Ore.
KENNEDY, LOWELL K., Des. & Estimator, Canadian Comstock Co., Ltd., Montreal, Canada.
KINGSBURY, NORMAN E., Jr. Engr., Stone & Webster Engineering Corp., Boston, Mass.

LADEWIG, FRED K., Sales Engr., The Trane Co., Kansas City, Mo.
LOCKLIN, DAVID W., Res. Engr., ASHVE Research Laboratory, Cleveland, Ohio.
LODGE, ROBERT H., Sales Engr., Murphy & Miller, Inc., Chicago, Ill.

MAXWELL, WILLIAM D., Mech. Designer, J. Donald Kroeker, Portland, Ore.
MCKENZIE, HILTON E., Field Serv. Engr., A. M. Byers Co., Charlotte, N. C.

PATTIZ, GENE B., Engr., General Installation Co., St. Louis, Mo.

SHELBY, LLOYD W., Engr., Dept. of Buildings & Power Plant, Vanderbilt University, Nashville, Tenn.
SHULL, DEAN E., JR., Mech. Engr., Hajoca Corp., Chattanooga, Tenn.
SPIEGEL, DANIEL, Jr. Engr., Consolidated Conditioning Corp., New York, N. Y.
SWANSON, ARDEN E., Engr., American Wheelabrator Equipment Corp., Mishawaka, Ind.

WATT, JOHN N., Engr., Watt Plumbing, Air Conditioning & Electric Co., Tulsa, Okla.
WEIDLE, BENJAMIN E., Precipitron Sales Engr., Westinghouse Electric Corp., St. Louis, Mo.
WINNER, ROBERT J., Test Engr., General Electric Co., Fort Wayne, Ind.

Student Members

ALLEN, EDWARD C., Student, A. & M. College of Texas, College Station, Tex.
ARAR, RAYMOND M., Student, University of Michigan, Ann Arbor, Mich.
ATKINSON, ROBERT P., Student, University of Minnesota, Minneapolis, Minn.

BETTENCOURT, HENRY J., JR., Student, A. & M. College of Texas, College Station, Tex.
BICHLER, JOSEPH S., Student, University of Michigan, Ann Arbor, Mich.
BOLIN, HAROLD W., Student, David Ranken Jr. School of Mechanical Trades, St. Louis, Mo.
BRELAND, BLISH, JR., Student, A. & M. College of Texas, College Station, Tex.
BRISKIN, BEN, Student, University of Michigan, Ann Arbor, Mich.
BROOKS, JACK A., Student, A. & M. College of Texas, College Station, Tex.

CLARK, JOHN W., Student, University of Michigan, Ann Arbor, Mich.
CONNORS, FRANCIS E., Student, David Ranken Jr. School of Mechanical Trades, St. Louis, Mo.

DUNBAR, DANIEL H., Student, University of Michigan, Ann Arbor, Mich.

Durkee, Myron C., Student, University of Michigan, Ann Arbor, Mich.

Erichsen, Erik, Student, Case Institute of Technology, Cleveland, Ohio.

Goodloe, James C., Jr., Student, A. & M. College of Texas, College Station, Tex.
Grew, Raymond E., Student, University of Michigan, Ann Arbor, Mich.
Grogin, Gerald K., Student, A. & M. College of Texas, College Station, Tex.

Jackson, Robert E., Jr., Student, A. & M. College of Texas, College Station, Tex.
Jamieson, John R., Jr., Student, University of Minnesota, Minneapolis, Minn.
Jensen, Alfred E., Student, A. & M. College of Texas, College Station, Tex.
Jorgensen, Earl W., Student, University of Michigan, Ann Arbor, Mich.

Kammeraad, Kenneth J., Student, University of Michigan, Ann Arbor, Mich.
Kane, Marshall E., Student, David Ranken Jr. School of Mechanical Trades, St. Louis, Mo.
Ketai, Mitchell R., Student, University of Michigan, Ann Arbor, Mich.
Kirkley, Charles R., Student, A. & M. College of Texas, College Station, Tex.

Lee, Chia-Chin, Student, University of Michigan, Ann Arbor, Mich.
Lee, Marvin N. T., Student, University of Minnesota, Minneapolis, Minn.
Lesley, P. Fred, Jr., Student, University of Michigan, Ann Arbor, Mich.
Linsky, Benjamin, Student, University of Michigan, Ann Arbor, Mich.
Loseman, John L., Student, David Ranken Jr. School of Mechanical Trades, St. Louis, Mo.

Luker, Martin, Jr., Student, A. & M. College of Texas, College Station, Tex.

Michels, Edward C., Student, A. & M. College of Texas, College Station, Tex.

Nelson, Franklin L., Student, David Ranken Jr. School of Mechanical Trades, St. Louis, Mo.
Nyman, Robert A., Student, University of Michigan, Ann Arbor, Mich.

Olivieri, Joseph B., Student, University of Detroit, Detroit, Mich.
Ownby, Robert W., Student, David Ranken Jr. School of Mechanical Trades, St. Louis, Mo.

Palmer, Jack C., Student, A. & M. College of Texas, College Station, Tex.

Quick, Leroy P., Student, David Ranken Jr. School of Mechanical Trades, St. Louis, Mo.

Rosenstein, David L., Student, University of Minnesota, Minneapolis, Minn.

Schrock, Robert E., Student, University of Michigan, Ann Arbor, Mich.
Schulte, Russell A., Student, David Ranken Jr. School of Mechanical Trades, St. Louis, Mo.
Stark, Roscoe C., Student, University of Michigan, Ann Arbor, Mich.
Stravolemos, Emanuel, Student, A. & M. College of Texas, College Station, Tex.

Tansil, John T., Student, A. & M. College of Texas, College Station, Tex.

Vaughan, Joseph E., Jr., Student, A. & M. College of Texas, College Station, Tex.

Walker, Morton T., Student, A. & M. College of Texas, College Station, Tex.
Walthall, Thomas J., Student, A. & M. College of Texas, College Station, Tex.
Weiss, Alex J., Student, University of Michigan, Ann Arbor, Mich.
Wigglesworth, George L., Jr., Student, University of Michigan, Ann Arbor, Mich.
Wilson, James H., Student, A. & M. College of Texas, College Station, Tex.

NEW FIRM ORGANIZED

George A. Belsky, a member of the Society for over 10 years, has recently formed an air conditioning contracting organization under the name of George A. Bell, Inc., with offices located in New York City.

Prior to opening his own office, Mr. Belsky was connected with Airtemp Div., Chrysler Corp., New York, N. Y., as a national account manager. Among the firms with which Mr. Belsky has held an important position during the 15 years he has been active in the air conditioning industry are the Majestic Refrigeration Corp., General Electric Co., and Nash Kelvinator Corp.

Mr. Belsky received his air conditioning training at the New York Technical Institute, where he later returned as an instructor, teaching drafting and sales engineering as applied to air conditioning. In addition to his membership in the ASHVE, Mr. Belsky also holds membership in the *ASRE*.

INSTITUTE OF GAS HEATING INDUSTRIES ELECTS OFFICERS

New officers for the *Institute of Gas Heating Industries*, an association of manufacturers and installers of gas heating equipment in Southern California, were formally inducted at an inauguration dinner-dance held on January 17, 1948. Among those taking office for the year 1948 were R. O. Montrief, vice president and general manager of Ward Heater Co., Los Angeles, who was elected president and A. B. Banowsky of Payne Furnace Co., who will serve as vice president. Mr. Banowsky is also an active member of the ASHVE.

Other new officers include W. R. Dicus of French Heating Co., as secretary-treasurer and R. B. Sutphen, J. P. Vein, Harry Haldeman and retiring president C. A. Gabriel, as members of the board of governors.

NEW LOCATION FOR C. A. DUNHAM CO.

H. S. Marshall, president of C. A. Dunham Co., Chicago, Ill., has announced the removal of company offices on January 3, 1948, from 450 East Ohio street, to the Daily News building, 400 W. Madison St. Occupying the new offices will be the administrative, sales, advertising, purchasing and auditing staffs

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Headquarters: 51 Madison Ave., New York 10, N. Y. (Tel.: MUrray Hill 3-0291)

Officers

President	G. L. Tuve
First Vice President	A. E. Stacey, Jr.
Second Vice President	L. T. Avery
Treasurer	L. E. Seeley
Secretary	A. V. Hutchinson
Technical Secretary	Carl H. Flink
Assistant to the President	C. A. McKeeman

Council

G. L. Tuve, *Chairman* A. E. Stacey, Jr., *Vice Chairman*

Three Years: D. M. Allen, F. A. Hamlet, C. S. Leopold, H. E. Sproull.

Two Years: M. W. Bishop, Carl F. Boester, Leo Hungerford, R. F. Taylor.

One Year: E. G. Carrier, F. W. Hutchinson, R. A. Sherman, M. S. Wunderlich.

Council Committees

Executive—G. L. Tuve, *Chairman;* L. T. Avery, A. E. Stacey, Jr., L. E. Seeley, *Ex-Officio.*

Finance—R. A. Sherman, *Chairman;* L. T. Avery, C. S. Leopold, L. E. Seeley, *Ex-Officio.*

Program and Papers—A. E. Stacey, Jr., *Chairman;* M. W. Bishop, F. W. Hutchinson.

Membership—R. F. Taylor, *Chairman;* E. G. Carrier, Leo Hungerford.

Advisory Council

Baldwin M. Woods, *Chairman;* Homer Addams, M. F. Blankin, W. H. Carrier, S. E. Dibble, S. H. Downs, W. H. Driscoll, E. O. Eastwood, W. L. Fleisher, H. P. Gant, F. E. Giesecke, E. Holt Gurney, L. A. Harding, H. M. Hart, C. V. Haynes, E. Vernon Hill, John Howatt, D. D. Kimball, G. L. Larson, S. R. Lewis, J. F. McIntire, Alfred J. Offner, F. B. Rowley, A. C. Willard and C.-E. A. Winslow.

Special Committees

Admission and Advancement—E. R. Queer, *Chairman;* T. F. Rockwell (*two years*), L. S. Ries (*three years*).

ASHVE *Code for Testing Heavy Duty Furnaces*—E. K. Campbell, *Chairman;* Bowen Campbell, R. S. Dill, F. A. Kitchen, A. P. Kratz, W. J. MaGirl, B. F. McLouth, F. L. Meyer, F. J. Nunlist, A. A. Olson, B. B. Reilly, Dr. H. J. Rose, H. A. Soper.

Constitution and By-Laws—S. H. Downs, *Chairman;* John James, H. E. Sproull.

Nominating—J. E. Haines, Minneapolis, Minn., *Chairman;* R. H. Carpenter, New York, N. Y., *Vice Chairman;* F. C. McIntosh, Pittsburgh, Pa., *Secretary;* C. M. Ashley, Syracuse, N. Y., Leo Garneau, Montreal, Que., Canada; John James, Cleveland, Ohio; G. W. F. Myers, St. Louis, Mo.; H. G. Richardson, Salt Lake City, Utah; G. B. Supple, Indianapolis, Ind.; Art Theobald, Los Angeles, Calif.; W. M. Wallace, II. *Alternates:* H. King McCain, Atlanta, Ga., and D. M. Mills, Houston, Tex.

Publication—John James, *Chairman;* R. S. Dill, S. S. Sanford, R. D. Madison, *Ex-Officio.*

Committee on Research

ASHVE Research Laboratory, 7218 Euclid Ave., Cleveland 3, Ohio (Tel.: EXpress 6161)

L. N. Hunter, *Chairman* R. D. Madison, *Vice Chairman*
Cyril Tasker, *Director of Research* A. C. Fieldner, *Ex-Officio*

Executive Committee: L. N. Hunter, *Chairman;* R. D. Madison, *Vice Chairman;* L. G. Miller, L. P. Saunders, W. E. Zieber.

Three Years: A. B. Algren, M. C. Giannini, F. W. Hutchinson, C. W. Johnson, W. E. Zieber.

Two Years: R. C. Cross, M. K. Fahnestock, John James, F. J. Kurth, T. H. Urdahl.

One Year: L. N. Hunter, C. O. Mackey, R. D. Madison, L. G. Miller, L. P. Saunders.

Chapter Delegates Committee 1948

Chapter	Delegate	Alternate
Atlanta	L. L. Barnes	Leo Sudderth, Jr.
Central New York	H. K. Ormsby	C. O. Mackey
Central Ohio	H. R. Allonier	W. M. Myler, Jr.
Cincinnati	H. K. Jennings	M. E. Mathewson
Connecticut	P. D. Bemis	A. J. Lawless
Delta	J. S. Burke	L. R. Maxwell
Golden Gate	John Everetts, Jr.	N. H. Peterson
Illinois	W. A. Kuechenberg	C. M. Burnam, Jr.
Indiana	T. R. Davis	I. W. Cotton
Iowa	C. A. Wheeler	D. C. Murphy
Kansas City	H. E. Gould	Henry Nottberg, Jr.
Manitoba	D. S. Swain	Einar Anderson
Massachusetts	Adolph Ehrenzeller	R. T. Kern
Memphis	E. E. Scott	
Michigan	A. E. Knibb	E. F. Hyde
Minnesota	L. C. Gross	B. F. McLouth
Montreal	T. H. Worthington	Leo Garneau
Nebraska	K. R. Magarrell	K. E. Martin
New York	M. C. Giannini	A. A. Bearman
North Carolina	E. S. deWitt	DeParx Stimson
North Texas	C. R. Gardner	G. A. Linskie
Northern Ohio	W. R. Moore	L. S. Ries
Oklahoma	G. T. Donceel	E. T. P. Ellingson
Ontario	E. G. Spall	A. J. Strain
Oregon	E. R. Lokey	C. W. Brissenden
Pacific Northwest	L. L. Bysom	J. D. Sparks
Philadelphia	J. O. Kirkbride	E. K. Wagner
Pittsburgh	B. B. Reilly	C. H. Schneider
Rocky Mountain	H. H. Herman	D. J. McQuaid
St. Louis	G. W. F. Myers	B. L. Evans
South Texas	L. L. Ladewig	C. C. Quin
Southern California	R. A. Lowe	R. S. Farr
Southwest Texas	G. R. Rhine	I. W. Wilke
Utah	C. E. Ferguson	E. V. Gritton
Virginia	D. E. Phillips	
Washington, D. C.	H. H. Hill	A. S. Gates, Jr.
Western Michigan	H. R. Limbacher	C. H. Pesterfield
Western New York	Roswell Farnham	Edwin Woolcock
Wisconsin	F. J. Nunlist	J. R. Vernon

OFFICERS OF LOCAL CHAPTERS

Atlanta: Organized, 1937. Headquarters, Atlanta, Ga. Meets, First Friday. President, L. L. Barnes, 3865 Wieuca Terrace. Secretary, R. L. Beach, 131 Clarion Ave., Decatur.

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Central New York: Organized 1944. Headquarters, Syracuse, N. Y. President, H. G. Strong, 300 S. Geddes St., Syracuse 1. Secretary, G. F. Keane, 316 Haddonfield Dr., DeWitt, N. Y.

Central Ohio: Organized, 1944. Headquarters, Columbus, Ohio. Meets, Third Monday. President, R. B. Breneman, 1282 Edgehill Rd., Columbus 8. Secretary, A. E. Norman, Jr., 1150 Chesapeake Ave., Columbus.

Cincinnati: Organized 1932. Headquarters, Cincinnati, Ohio. Meets First Tuesday. President, H. K. Jennings, 1639 Union Trust Bldg., Cincinnati 2. Secretary, K. B. Little, 832 Temple Bar Bldg., Cincinnati 2.

Connecticut: Organized, 1940. Headquarters, New Haven, Conn. President, S. R. Osborne, Waterbury 91. Secretary, Winfield Roeder, 405 Temple St., New Haven.

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Delta: Organized, 1939. Headquarters, New Orleans, La. Meets, Second Tuesday. President, J. S. Burke, 317 Baronne St., New Orleans 9. Secretary, R. B. Guest, 827 Dryades St., New Orleans 13.

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Golden Gate: Organized, 1937. Headquarters, San Francisco, Calif. Meets, First Wednesday. President, F. W. Kolb, 598 Monadnock Bldg., San Francisco 5. Secretary, K. F. Baldwin, Jr., 419 Kentucky Ave., Berkeley 7.

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Illinois: Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, W. A. Kuechenberg, 1714 Sheffield Ave., Chicago 14. Secretary, G. W. Bornquist, 629 W. Washington Blvd., Chicago 6.

Indiana: Organized, 1943. Headquarters, Indianapolis, Ind. Meets, Fourth Friday. President, I. W. Cotton, 1035 N. Pennsylvania St., Indianapolis 4. Secretary, W. R. Fenstermaker, 215 E. New York St., Indianapolis 4.

Iowa: Organized, 1940. Headquarters, Des Moines, Ia. Meets, Second Tuesday. President, C. A. Wheeler, 1217 Grand Ave., Des Moines. Secretary, D. E. Wells, 304 Home Federal Bldg., Des Moines 9.

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Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets, First Monday. President, P. C. Leffel, 3323 Main St., Kansas City 2. Secretary, Henry Nottberg, Jr., 914 Campbell, Kansas City.

●

Manitoba: Organized, 1935. Headquarters, Winnipeg, Man., Canada. Meets, Third Thursday. President, D. S. Swain, 1186 Downing St., Winnipeg. Secretary, A. W. Moss, 26 Ferndale Ave., Norwood, Manitoba.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, Adolph Ehrenzeller, 329 Washington St., Dorchester 21. Secretary, R. T. Kern, 51 Claflin St., Leominster.

Memphis: Organized, 1944. Headquarters, Memphis, Tenn. Meets, First Monday. President, N. C. Ledbetter, 22 S. Cooper St., Memphis 4. Secretary, A. T. Bevil, 1521 Waverly Ave., Memphis 6.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, A. E. Knibb, 1003 Maryland Ave., Detroit 30. Secretary, L. A. Burch, 5853 Hamilton Ave., Detroit 2.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, L. C. Gross, 5324 Oaklawn Ave., Minneapolis 10. Secretary, L. J. Krause, 2753 4th Avenue S., Minneapolis 8.

Montreal: Organized, 1936. Headquarters, Montreal, Que., Canada. Meets, Third Monday. President, T. H. Worthington, 405 Beaubien St. W., Montreal, Que. Secretary, S. W. Salter, 910 New Birks Bldg., Montreal.

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Nebraska: Organized, 1940. Headquarters, Omaha, Neb. Meets, Second Tuesday. President, Verne Simmonds, 2416 Vane St., Omaha. Secretary, G. W. Colburn, 106 N. 15th St., Omaha 2.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, M. C. Giannini, New York University, New York 53. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, E. S. deWitt, 1211 Commercial Bank Bldg., Charlotte. Secretary, R. M. Warren, Jr., 1001 N. Church St., Charlotte 1.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, B. S. Foss, Jr., 711 Construction Bldg., Dallas 1. Secretary, Herman Blum, Jr., 2812 Fairmount, Dallas 4.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, Ohio. Meets, Second Monday. President, John James, 3170 W. 1[illegible]th St., Cleveland 11. Secretary, W. M. Rowe, 1302 Swetland Bldg., Cleveland 15.

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Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, W. W. Frankfurt, 519 Apco Tower, Oklahoma City. Secretary, J. H. Spaan, Jr., 1303 N. Klein, Oklahoma City 6.

Ontario: Organized, 1922. Headquarters, Toronto, Ont., Canada. Meets, First Monday. President, D. A. Stott, 195 Spadina Ave., Toronto. Secretary, H. R. Roth, 57 Bloor St., W., Toronto, Ont.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, C. W. Brissenden, Electric Bldg., Portland 5. Secretary, L. G. Williams, Box 304, Gladstone.

●

Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, E. H. Langdon, 72 Vine St., Seattle. Secretary, E. J. Rosen, 10238 18th Ave., S. W., Seattle 66.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, E. H. Dafter, 12 S. 12th St., Philadelphia 7. Secretary, E. K. Wagner, 2240 N. Broad St., Philadelphia 32.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, D. W. Loucks, 435 Sixth Ave., Pittsburgh 19. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

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Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, J. F. Mohan, 2229 Blake St., Denver 2. Secretary, H. C. Kugeler, 2365 Ash St., Denver 7.

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St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, J. H. Carter, 710 Key West Ave., Webster Groves 19. Secretary, J. S. Rosebrough, 1014 Arcade Bldg., St. Louis 1.

South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, D. M. Mills, Gray and Crawford, Houston 3. Secretary, L. L. Ladewig, Box 1188, Houston 1.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Third Wednesday. President, R. A. Lowe, 6381 Hollywood Blvd., Los Angeles 28. Secretary, John L. Blake, 1700 S. Bedford St., Los Angeles 35.

Southwest Texas: Organized, 1946. Headquarters, San Antonio, Tex. President, F. C. Benham, Jr., 702 S. Flores St., San Antonio. Secretary, L. S. Pawkett, 810 Insurance Bldg., San Antonio 5.

●

Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, E. V. Gritton, 2470 S. 15th, Salt Lake City 5. Secretary, C. E. Ferguson, 838 Garfield Ave., Salt Lake City.

●

Virginia: Organized, 1946. Headquarters, Norfolk, Va. President, W. H. Webster, Jr., 933 W 21st St., Norfolk. Secretary, D. E. Phillips, P. O. Box 674, Newport News.

●

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, H. H. Hill, 438 Woodward Bldg., Washington 5. Secretary, J. G. Muirheid, 2013 New Hampshire Ave., N. W., Washington 9

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, Frank Harbin, Jr., 280 E. 6th St., Holland. Secretary, W. C. DeRoo, 500 E. 8th St., Holland.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, G. E. Adema, 39 W. Balcom St., Buffalo 9. Secretary, J. H. Bryce, 88 E. Girard Blvd., Kenmore.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, J. R. Vernon, 507 E. Michigan St., Milwaukee 2. Secretary, B. M. Kluge, 1817 S. 66th St., Milwaukee 14.

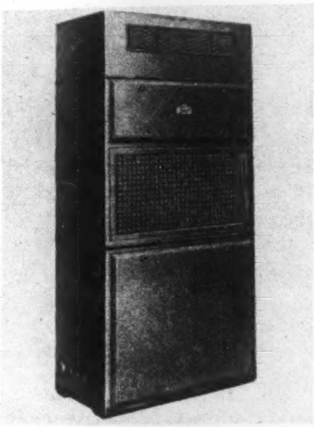
Student Branch

Texas A. & M. College: Organized, 1946. Headquarters, College Station, Tex. Meets, Third Thursday. President, S. E. Ammons, 212 13th Ave., No., Texas City. Secretary, C. P. Howard, Box 1706, College Station.

EQUIPMENT DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1948 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

Packaged Air Conditioning Unit Designed for Commercial Use

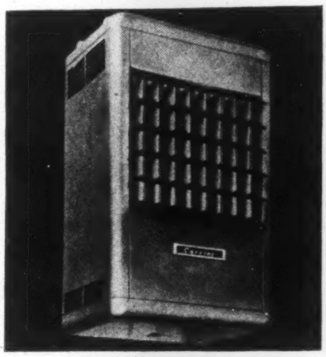


No. 3689—A five ton packaged air conditioner, designed especially for stores, restaurants, and business houses, is now being produced by Frigidaire Div., General Motors Corp., Dayton 1, Ohio.

Occupying 7½ ft of floor space, the new unit is completely self contained and includes the compressor-condenser unit, motors, cooling coils, fans, and air filters. All electrical, water, and drain connections are grouped for easy assembly and dismantling, and for winter operation, a heating coil can be added. Conditioned air is handled by a 12 in. fan driven by a ¾ hp motor. The refrigeration unit is powered by a 5 hp, three phase, 220 volt motor.

Flexibility, low cost installation, and portability are said to be principal advantages of these units which may be used singly or in multiple.

Gas Fired Unit Heater Features Welded Steel Construction



No. 3690*—Available in six sizes, ranging from 65,000 to 200,000 Btu per hr input, a completely new gas fired unit heater (type 46T) has been announced by Carrier Corp., 302 S. Geddes St., Syracuse 1, N. Y.

Designed for either manufactured, natural, or mixed gas, the heater features a heat interchanger and combustion chamber assembly which is made of "aluminized" heavy gage steel, completely electric welded. Burners are interchangeable for various gas mixtures, are of cast iron, and are said to be warpless. Air for combustion and for the built-in draft diverter intake is drawn from the sides of the unit, away from the heated air stream. All motors, fans, and controls are standard products of wellknown manufacturers. The controls include an automatic safety pilot and high temperature limit control.

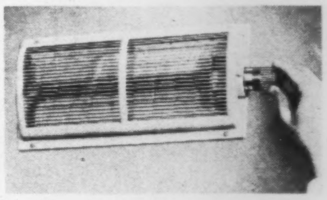
Pipe Insulation Made of Cellular Glass

No. 3691—The first pipe insulation that can be used for both hot and cold lines, indoors and outdoors, is said to be the new "Foamglas" insulation developed by Pittsburgh Corning Corp., 632 Duquesne Way, Pittsburgh 22, Pa.

According to the manufacturer, the new product, of cellular glass construction, retains its original insulating efficiency permanently, is unaffected by humidity as it is waterproof and vaporproof, is noncombustible, and is highly resistant to fumes, vapors, and acid atmospheres.

The insulation is available in two half sections, 18 in. long, for all sizes of pipe, and when installed in accordance with the manufacturer's recommendations, is suitable for temperatures from −200 F to 800 F. It is also said to be strong, rigid, lightweight, and easy to cut and fit with ordinary tools.

Warm Air Register Thermostatically Controlled



No. 3692*—The "Thermo-Matic" register for controlling individual room temperatures in old or new buildings has recently been introduced by Dole Valve Co., 1933 Carroll Ave., Chicago 12, Ill. The primary purpose of the new register is to regulate the warm air input from each register in direct relationship to the heat loss from each room.

Units are normally placed in the "easy to heat" rooms so that these rooms will not overheat before other spaces reach the desired temperature. A turn of the dial, on the right hand side of the register, is said to assure automatic control of the heated air from the register. The manufacturer is emphatic in stating that the regulating thermostatic element is actuated not by the air blast from the register but by air from the room. Chief feature of the new register is the application of an aspirator principle which draws circulating room

Heating, Piping & Air Conditioning **[3-48]**
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature

(Circle each number in which you are interested)

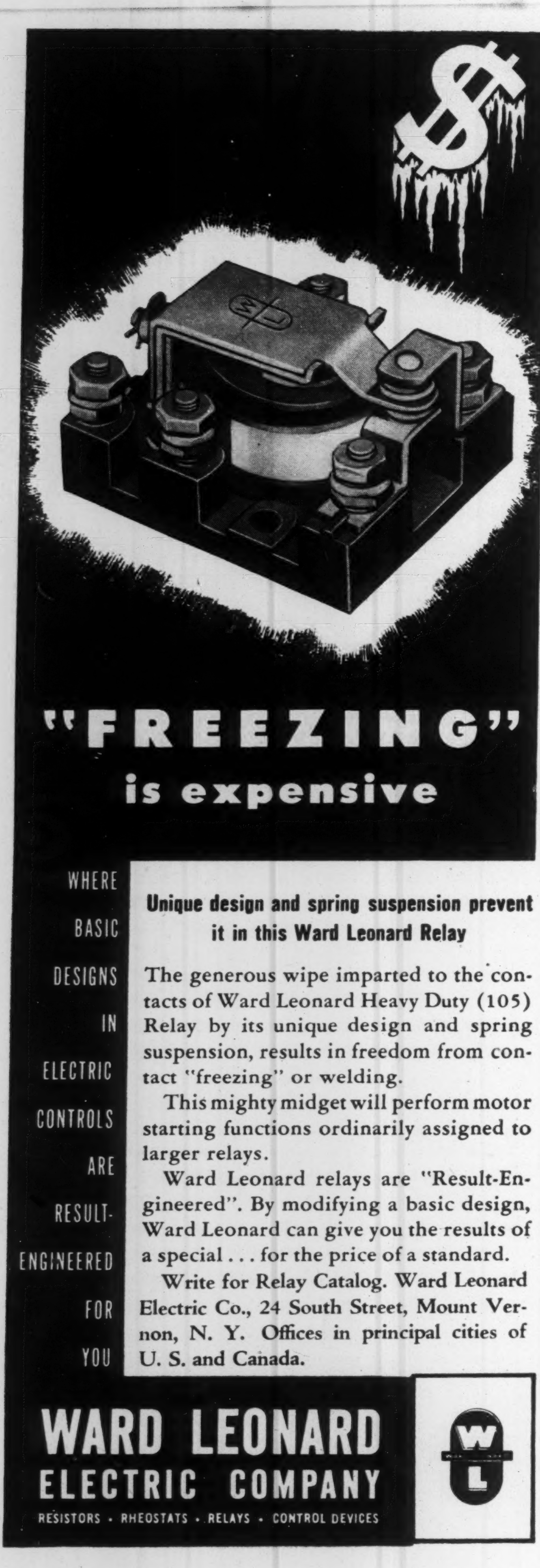
3689	3690	3691	3692	3693	3694	3695	3696	3697	3698
3699	3700	3701	3702	3703	3704	3705	3706	3707	3708
3709	3710	3711	3712	3713	3714	3715	3716	3717	3718
3719	3720								
6779	6780	6781	6782		6784	6785	6786	6787	6788
6789	6790	6791	6792	6793	6794	6795	6796	6797	6798
6799	6800	6801	6802	6803	6804	6805	6806	6807	6808
6809									

Name............................ **Title**................

Company ....

Address ....

City........................ **Zone**...... **State**...........



"FREEZING" is expensive

WHERE BASIC DESIGNS IN ELECTRIC CONTROLS ARE RESULT-ENGINEERED FOR YOU

Unique design and spring suspension prevent it in this Ward Leonard Relay

The generous wipe imparted to the contacts of Ward Leonard Heavy Duty (105) Relay by its unique design and spring suspension, results in freedom from contact "freezing" or welding.

This mighty midget will perform motor starting functions ordinarily assigned to larger relays.

Ward Leonard relays are "Result-Engineered". By modifying a basic design, Ward Leonard can give you the results of a special . . . for the price of a standard.

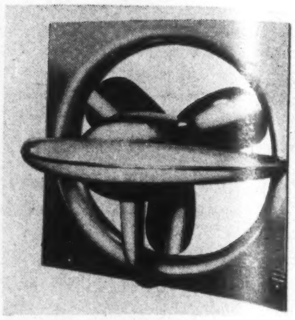
Write for Relay Catalog. Ward Leonard Electric Co., 24 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

temperature air at the rate of about 75 fpm over the thermostatic element.

Propeller Fan Has Streamlined Design

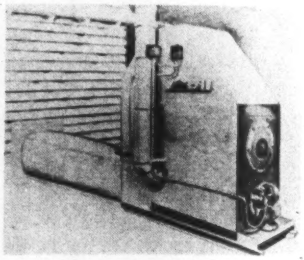


No. 3693—Free flowing lines which are said to harmonize with the architectural motif of modern business establishments are the design features in the new streamlined model A "Ventura" propeller fans offered by American Blower Corp., Detroit 32, Mich.

Built in 12 sizes, units are available in capacities from 1000 to 9700 fpm free delivery. The trade name is used to designate the venturi like throat in which the wheel revolves. This is said to be one of the important factors in the efficiency of the fan.

Also available are four other models in a wide variety of sizes for commercial and industrial applications.

Uses Portable Air Heater to Dry Corn



No. 3694*—The "Powerated" mobile corn dryer is now available from Jackson & Church Co., Saginaw, Mich. According to the manufacturer, the unit is pointed toward small tonnage corn drying problems where mobility of the heating unit is important. Dryers are now being used commercially for hybrid and cereal corn, grains, hops, and wood.

Heater output is in excess of 460,000 Btu per hr, and 70 to 75 percent thermal efficiency is claimed. Features are said to include the use of a stainless steel combustion chamber, a heater body of welded 10 gage boiler plate steel, a nonoverloading fan capable of handling 6500 cfm against an external static pressure of ½ in., or 5500 cfm against 1½ in., and a baffled and reinforced heating element. An atomizing pressure type oil burner is used.

Acquires Stoker Division

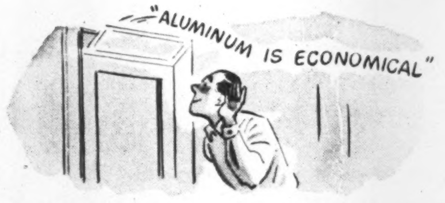
No. 3695—The Timken-Detroit Axle Co., has acquired the stoker division of Link-Belt Co., Chicago, according to a recent announcement.

Link-Belt has manufactured since 1933 a full line of stokers, both hopper and bin feed types, for domestic, commercial, and industrial use. Bituminous stokers in the line range upward in size to capacities of 1250 lb per hr, and anthracite models range from 25 to 50 lb per hr in capacity.

According to the announcement, Link-Belt's manufacturing, sales, service, distributor, jobber, and dealer organizations will function under the supervision of the Timken Silent Automatic Division which now manufactures oil burners, oil and gas furnaces, boilers, water heaters, and related products.

Things you hear in smart shops

(Is yours one of them?)



Certainly! Almost anyone can afford low-priced Kaiser Aluminum Utility Sheet. And it saves money other ways, too. It's easy to assemble and erect, so it takes less labor, is less wearing on shop equipment, and produces less scrap loss.

"ALUMINUM IS EASY TO JOIN"

Correct! You can make a Pittsburgh Lock Seam perfectly with Kaiser Aluminum Utility Sheet. And in making up fittings, you can easily form and join it neatly. You can fasten it with rivets, by welding, with sheet metal screws or by brazing.

"ALUMINUM IS TOUGH"

Right! You don't have to handle Kaiser Aluminum Utility Sheet with kid gloves. You can treat it as you would any sheet metal. It's light but strong, and sheet metal men like to work with it. Lasts for generations, too—never rusts, never needs painting or maintenance.

"ALUMINUM CAN BE EASILY HANDLED"

You bet! With your present standard equipment you can do the same things with Kaiser Aluminum Utility Sheet you're now doing with other metals. You can shear it, blank it, emboss it, punch it, route it, drill it and bend it with ease.

Whether or not you're held back by shortages—
investigate Kaiser Aluminum Utility Sheet *today!*

Kaiser Aluminum Utility Sheet

a Permanente Metals product

SOLD BY PERMANENTE PRODUCTS COMPANY, KAISER BLDG., OAKLAND 12, CALIFORNIA ... WITH OFFICES IN:
Atlanta • Boston • Buffalo • Chicago • Cincinnati • Cleveland • Dallas • Detroit • Kansas City • Los Angeles • Milwaukee • Minneapolis
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THE AIR YOU BREATHE SHOULD BE AS PURE AS THE WATER YOU DRINK

CUT YOUR COSTS WITH DIRECT DRIVE

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ILG ELECTRIC VENTILATING CO.
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ILG VENTILATION

Save dollars on every job with ILG Direct-Drive Centrifugal Fans. No time-wasting alignment, no belts or pulleys to increase labor and material costs. No special motor bases to boost your costs, no belt or chain guards to buy and install, no extras to reduce your profits!

You handle more jobs with the same man power, while giving your customer the best possible equipment. You save space, you have permanent alignment (no rapidly wearing parts). You avoid frequent shutdowns for replacement or servicing of parts. You eliminate power-wasting friction and noise. Your ILG equipment delivers full rated capacity.

Get latest data on ILG profit-makers—phone nearby Branch Office (consult classified directory) or send coupon.

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ILG ELECTRIC VENTILATING CO., 2841 N. Crawford Ave.
Chicago 41, Ill. Offices in more than 40 Principal Cities.

☐ Send free copy new Catalog No. 247.

Firm Name______________________________

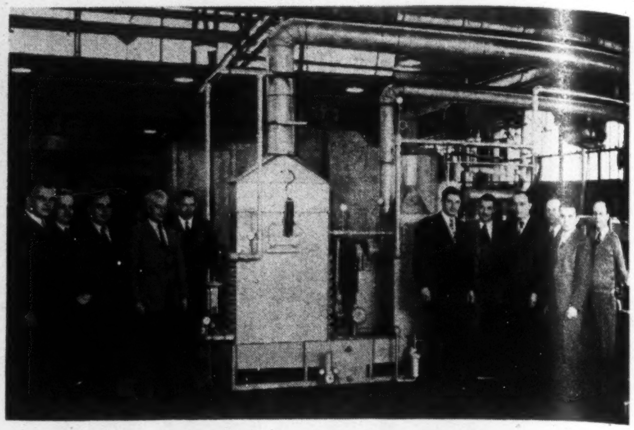
Individual__________________ Title__________

Address________________________ Zone_____

City__________________________ State________

Packaged Dehumidifying Unit Made More Compact

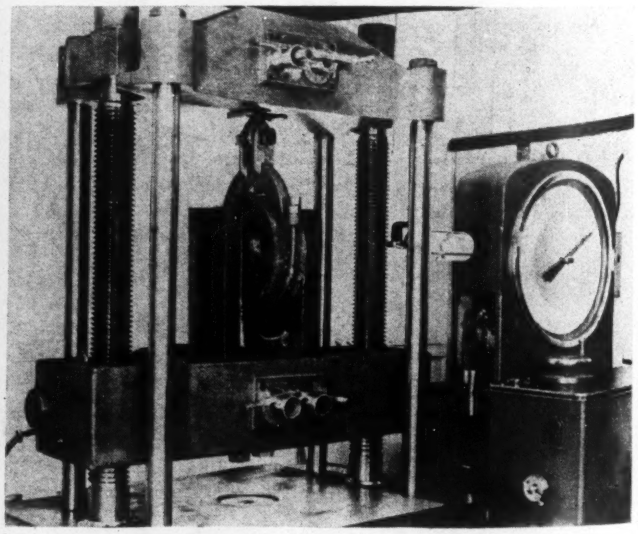
No. 3696—The new model B "Kathabar" packaged dehumidifying unit has recently been developed by Surface Combustion Corp., 2375 Dorr St., Toledo 1, Ohio.



The new model, which operates on the same principle of absorption as the previous model A packaged unit, is said to be much more compact and is erected and disassembled by sections to facilitate its being moved through doorways and common openings in buildings. Sizes are available to handle from 1350 to 5000 cfm of air.

Offers Pipe Clamps for High Temperature Service

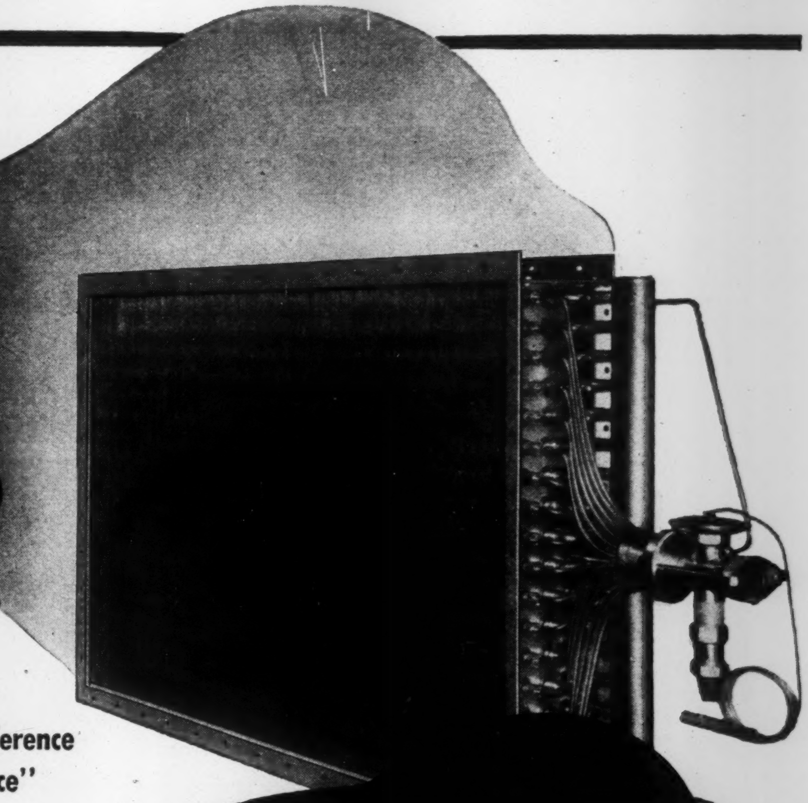
No. 3697—Grinnell Co., Inc., Providence, R. I., has undertaken to supply the demand for high temperature pipe clamps in seven sizes from 4 in. through 16 in. with a commercial clamp made of chrome vanadium steel as a one piece drop forging and equipped with a u bolt of the same material. These, says the company, are expected to meet the major portion of high temperature pipe clamp requirements at temperatures up to 1000 F without a high cost penalty.



Shown here is a 14 in. pipe clamp set up in a tensile testing machine prior to being pulled to destruction at 66,300 psi.

Load ratings of the clamps for the various pipe sizes have been established after a series of tensile strength

ONLY KENNARD *Engineered* COILS GIVE YOU . . .



"Refinement of Detail Marks the Difference Between Mediocrity and Excellence"

No wonder so many engineers and contractors are specifying KENNARD all the way for their HEAT TRANSFER PRODUCTS.

These fine quality coils offer many exclusive advantages that make for satisfying service and longer life at no higher cost.

KENNARD COILS are designed and built by an organization that *specializes* in heat transfer products . . . an organization with the equipment, the personnel, and the engineering "know-how" to do the job best. We are equipped to fabricate ANY type of heating or cooling coils (any refrigerant) on prompt delivery schedules. Your inquiries are invited.

CLEANER INSIDE SURFACE

Hydrualic stretching loosens scale and oxides subsequently blown OUT of coil reduces danger of scoring compressor.

SAFER COIL
Having withstood 3000 psi for bonding is safe-guarded against leaks.

UNIFORM EVEN STRESS
in ALL fins—good mechanical and thermal bond.

NO-RUST FRAMES

Frames up to 72" are ALUMINUM. Larger sizes framed in steel, hot-dipped galvanized AFTER fabrication.

ONE-PIECE FINS

(All Lengths)
Solid plate type fin for ALL coils. Reduces air resistance. Requires less fan power. Minimizes fuzz and lint fouling.

Kennard Engineered
FINNED COILS
KENNARD CORPORATION

Write for
KENNARD CATALOG 47-A
(Finned Coils).
Crammed full of authoritative data with pages of tables to simplify making coil selections.

OTHER KENNARD CATALOGS
No. 4710—Unit Heaters (Horizontal)
No. 481—Air Conditioning and Blower Units

COOLING COILS
HEATING COILS

KENNARD CORPORATION

1817 S. Hanley Rd., St. Louis 17, Mo.

BLOWER UNITS
AIR CONDITIONING
INDUSTRIAL

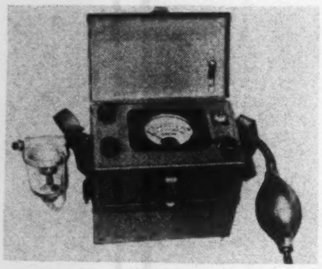
tests. On the basis of the results, maximum recommended load ratings have been established for their use on piping at various elevated temperatures in accordance with the code for pressure piping.

Develops New Line of Forged Steel Valves

No. 3698—A new line of 600 lb forged steel valves has been announced by Ohio Injector Co., 275 Main St., Wadsworth, Ohio, manufacturer of iron, steel, and bronze valves.

The new units, available with various types of trim, are offered in the screwed, flanged, and socket welded types. Gate, globe, angle, and check valves are included in the line, and each valve bears an identification plate describing the trim, pressure-temperature range, and catalog number.

Indicates Lower Explosive Limit and Toxic Range of Gases, Vapors

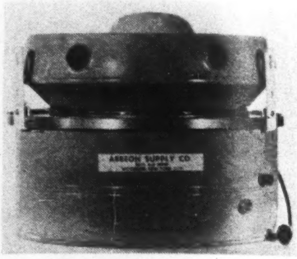


No. 3699—For the determination of hazardous conditions due to the presence of combustible or explosive concentrations of flammable gases or vapors, the Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark 4, N. J., has developed a new "Vapotester." The new model 6 is a two range instrument which is designed to increase the sensitivity ten fold.

One range analyzes combustible gases in terms of their lower explosive limit. A second scale indicates gases in their toxic range. The basic principle of the indicator is the measurement of increases in the resistance of a filament when exposed to a gas or vapor-air mixture as compared with a filament not exposed to such gas or vapor-air mixture.

The two filaments, as two legs of a balanced wheatstone bridge circuit, are housed in a single cell block having two chambers.

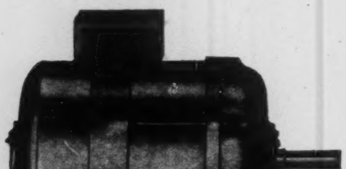
Filter Used at Air Intake of Industrial Humidifier



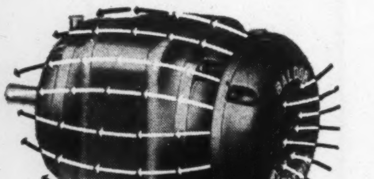
No. 3700**—Walton Laboratories, Inc., 1186 Grove St., Irvington 11, N. J., is now producing a new industrial humidifier in which the lower pan is completely covered and the air is brought in from the bottom through a glass fiber filter which is said to greatly reduce cleaning time.

Equipped with hanging brackets, all that is necessary is to hang the unit from the ceiling and run a single water pipe to it; no return water line being needed. Automatic controls are furnished.

Construction and design features are said to include vaporization capacity of over 1 gph, the use of heavy



Open, drip-proof construction; 1/6 to 1/3 h. p., 1 phase, 3 phase and Direct Current.



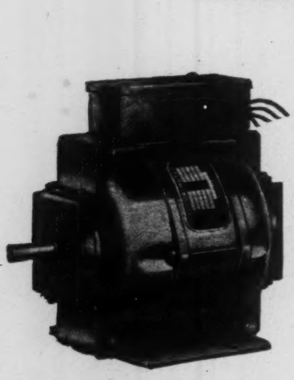
Arrows indicate forced air-movement over ENTIRE EXTERIOR of BALDOR STREAMCOOLED Motor.

Single Phase, 3/4 to 7 1/2 h. p.
3-Phase, 1 to 20 h. p.
Direct Current, 1 to 3 h. p.

STREAMCOOLED, round frame, 1/3 to 3/4 h. p., 1 phase, 3 phase and Direct Current.

BALDOR builds a Complete Line of Motors for
HEATING, VENTILATING and AIR CONDITIONING EQUIPMENT

These BALDOR Motors have won national acceptance because of their cool-running, quiet, efficient operation. Many manufacturers in your industry have consistently used them for more than 25 years.

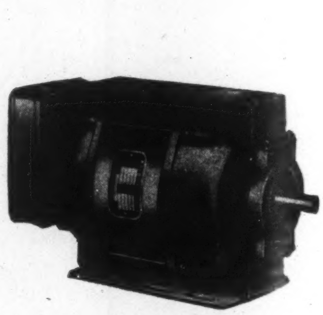


Resilient-mounted, open, drip-proof, for belt drive; 1/10 to 3/4 h. p., single phase.

Baldor

ST. LOUIS, MO.
AND PRINCIPAL CITIES

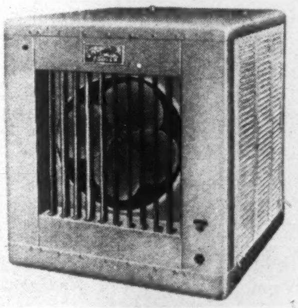
BETTER MOTORS
FOR MORE THAN A QUARTER CENTURY



Resilient-mounted fan motor, 1/30 to 1/2 h. p., 1 phase; 1/6 to 1/2 h. p., 3 phase.

gage copper or other nonferrous material throughout, and the availability of single directional, two directional, or 360 deg directional domes.

Evaporative Cooler Offered For Many Applications



No. 3701 — The Palmer Mfg. Corp., 705 W. Jefferson St., Phoenix, Ariz., is now producing a new "Sno Breze Super" model S 3000 evaporative cooler. The unit is designed for use in small plants, homes, offices, tourist courts, trailers, etc.

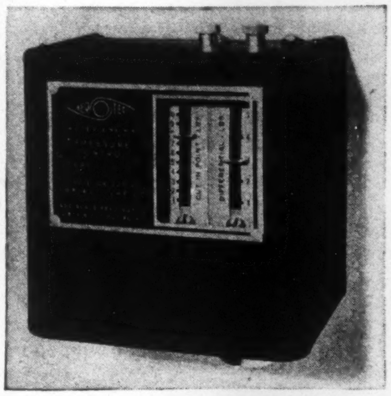
Powered by a slow speed propeller type fan, the 32x28x28 in. unit delivers 3000 cfm and is usually installed in a window or on the side of a building. Equipment furnished includes a water regulating valve and switch, a rust resisting cabinet with filter pad louvers, an adjustable trough drip system, and a recessed adjustable air grille.

Displays Refrigeration Tools

No. 3702—Many new refrigeration tools were displayed by Bonney Forge & Tool Works, Allentown, Pa., at the recent Fifth All-Industry Refrigeration and Air Conditioning Exposition.

Among the tools shown were a reversible ratchet, a small hack saw, offset screw drivers, a small plier set, clutch head screw drivers, hexagonal keys, a bushing driver set, and a flaring tool.

Ease of Adjustment Features Temperature, Pressure Controls



No. 3703 — First in a list of new controls to be placed on the market through the national distributor, The Thermix Corp., First National Bank Bldg., Greenwich, Conn., are the H-701 pressure control (shown here) and the T-701 hot water, immersion type temperature control manufactured by Aerotec Corp.

Easy "fingertip adjustment", clearly visible scales, and rugged construction are some of the features claimed.

The pressure control is available for 110 volt, 10 amp or 220 volt, 5 amp. It is suitable for single pole, single throw, or double throw use and is rated at ½ hp. The pressure range is adjustable from 1 to 15 psi and the differential from 1 to 5 psi.

The temperature control unit has a fixed differential of 10 F and a range adjustment from 60 to 200 F. A microswitch is used for the electrical contact and is designed for 110 volt, 10 amp or 220 volt, 5 amp use. It is normally closed.

McCORD
HEATING AND
AIR CONDITIONING
PRODUCTS

BLAST HEATING COILS—AIR CONDITIONING COILS—ALL TYPES

All copper spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded. May we send catalog?

VERTICAL TYPE UNIT HEATERS

A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

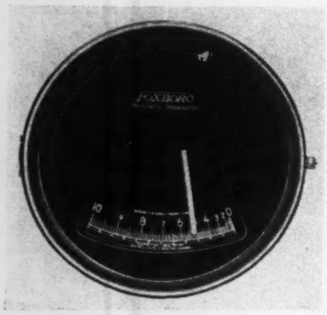
HORIZONTAL TYPE UNIT HEATERS

A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

Save fuel with McCord Unit Heaters.

McCord CORPORATION
DETROIT 11, MICH.

Improved Accuracy in Pneumatic Transmitter



No. 3704—A new transmitter, identified as model 42, has been announced by the Foxboro Co., 106 Neponset Ave., Foxboro, Mass., for use in the pneumatic transmission of industrial process measurements such as flow, static or differential pressure, liquid level, temperature, or humidity. It is an indicator type instrument, available with either an eccentric or concentric scale, both being designed for quick and easy reading.

The unit is essentially an improved design of the company's previous transmitter, but the changes are said to be sufficient to qualify it as a new instrument. The most important of these is a completely new transmitting element which is exactly duplicated in the receiving instrument, so that improved accuracy in transmission results. Simplified calibration is another feature.

The familiar round form case has been retained, but whereas the previous transmitter was in a 10 in. case, a 12 in. case is now used. This is said to permit better location of the instrument parts, to facilitate field servicing, and also to provide room for additional units, such as alarm or signal devices, when desired.

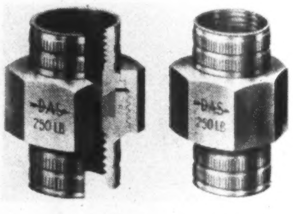
Single Stage Centrifugal Pump Has Vertically Split Case

No. 3705—A general utility centrifugal pump, the "Fluidyne", with power drives from fractional to 20 hp has been introduced by Peerless Pump Div., Food Machinery Corp., 301 West Ave., 26, Los Angeles 31, Calif.

The unit, which is of the single stage, end-suction type with vertically split case, is manufactured in two types and in capacities up to 1000 gpm at heads up to 270 ft. Type PE is an integrally coupled unit and type PB is designed for belt drive.

According to the manufacturer, the pump will operate in any position and eight or more positions of the discharge opening (depending upon pump size) provide flexibility of installation. Features are said to include ease of maintenance and accessibility, together with high efficiency.

Test Union for High Pressures Made From Bar Stock



No. 3706**—A new type 750 psi test union for high or low pressure piping is now offered by the Defiance Automatic Screw Co., Fort Wayne Rd., Defiance, Ohio.

The union is made from carbon steel bar stock and is said to have withstood pressures up to 1500 psi without distortion or leakage. Available in sizes up to and including 1 in., the unit incorporates a brass seat to resist wear and corrosion.

AIRTHERM
DIRECT-FIRED
WARM AIR HEATERS

Offer You These Six Heating Advantages

1. A complete factory heating unit.
2. Comes to you ready to set in place.
3. Control system wired at factory.
4. Available in floor-mounted or suspended models.
5. Oil burners or gas burners are interchangeable to meet future fuel conditions.
6. Capacities from 650,000 to 1,950,000 BTU per hour.

For detailed information, write for Bulletin 801-A.

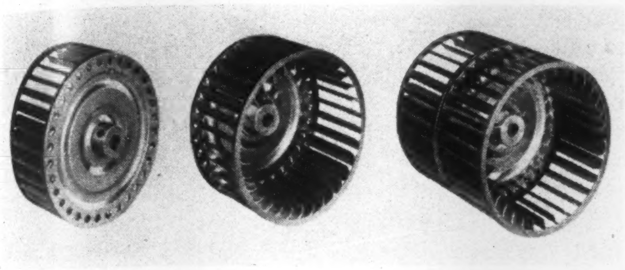
AIRTHERM
MANUFACTURING CO.

711 South Spring Ave. • St. Louis, Mo.

55

Blower Wheel Designed for Improved Performance

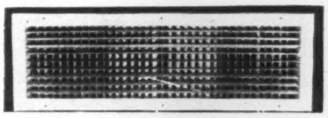
No. 3707—An all-welded blower wheel, the "Weld-wheel", has been announced by Lau Blower Co., 2001 Home Ave., Dayton 7, Ohio.



Improved performance, including greater volumes at higher pressures per horsepower, is said to result from the design of individual blades which are deeper and have better curvature, together with the use of a larger number of blades. Other advantages are said to include 25 percent reduction in weight and increased strength.

The new wheels are made in 5, 6¼, and 7½ in. diameters. Capacities are from 50 to 600 cfm. Various hubs are available and wheel widths may be made down to 1⅛ in.

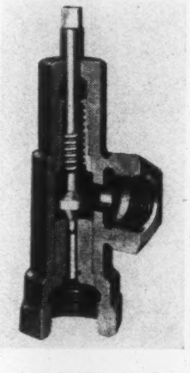
Airfoil Design Used in Grilles and Registers



No. 3708—Titus Mfg. Corp., P.O. Box 591, Waterloo, Iowa, has announced a new line of air diffusion registers and grilles featuring the new "Waterloo" airfoil louver.

Patterned after the airfoil section of an airplane, the design is said to permit handling higher volumes and velocities with a small amount of resistance. The grilles can be furnished in any size without mullions or butted construction. Blades are inserted and tensioned in the frame with a new device which, the company claims, assures uniform tension and prevents freezing or locking of adjustable louvers.

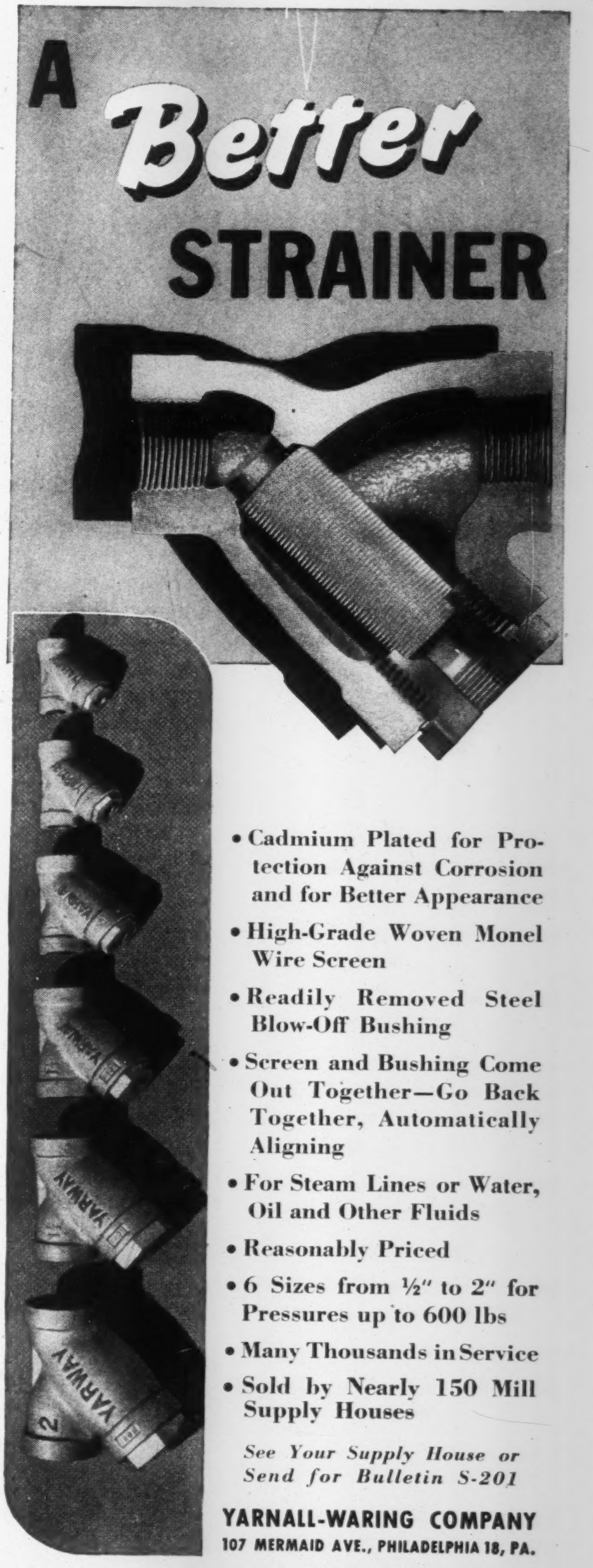
Gas Valve Incorporates Tamperproof Design



No. 3709—Designed for high pressure gas service up to 150 psi, a new G-452H.P. nonlubricated brass valve has been announced by Welsbach Corp., Kitson Div., Philadelphia, Pa.

This new valve, for use on medium and high pressure service lines just ahead of the gas regulator, is said to be constructed so that tampering is impossible without removing the entire valve from the line. Metal to metal seating is provided for both the open and shut positions. The upper part of the valve stem has a milled square for application to any specified type of handle.

The unit is available in 1 in. inlet by ¾ in. outlet size, and with ¾ x 1 in. brass adaptors for the inlet, though standard steel bushings are recommended.

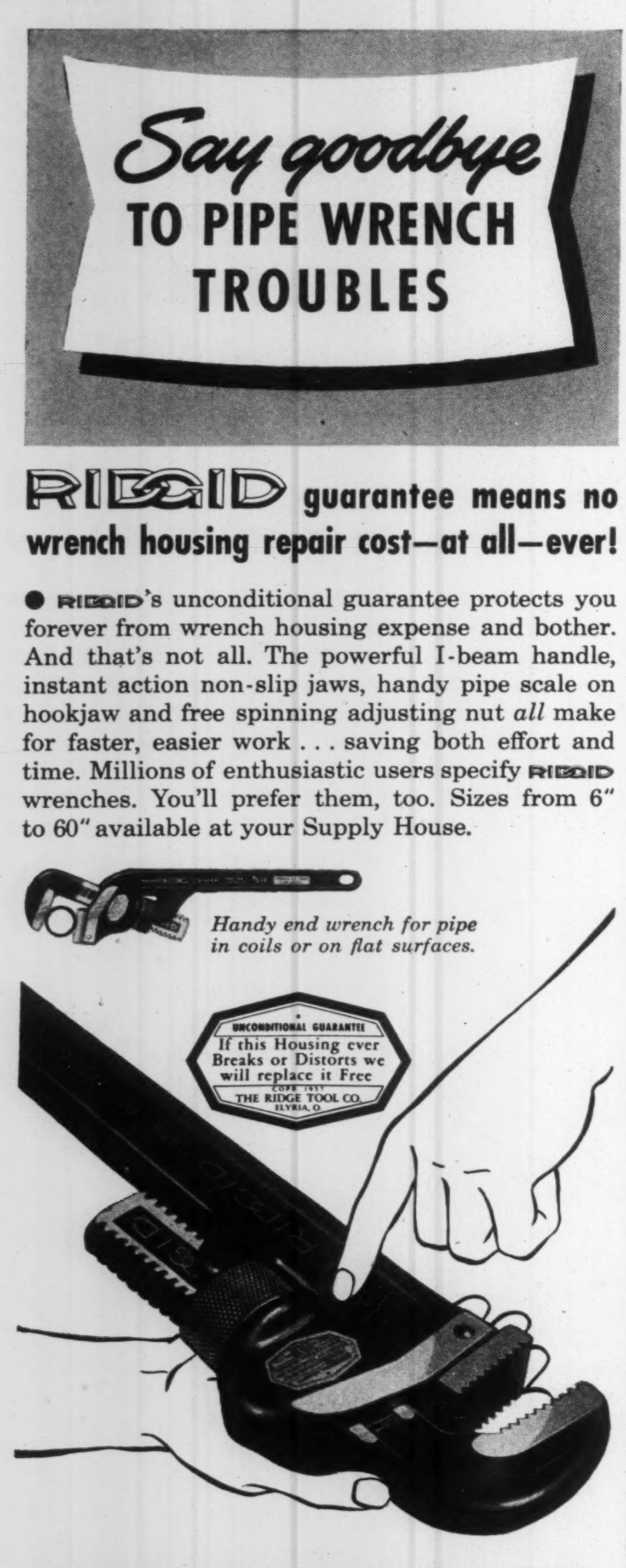


- Cadmium Plated for Protection Against Corrosion and for Better Appearance
- High-Grade Woven Monel Wire Screen
- Readily Removed Steel Blow-Off Bushing
- Screen and Bushing Come Out Together—Go Back Together, Automatically Aligning
- For Steam Lines or Water, Oil and Other Fluids
- Reasonably Priced
- 6 Sizes from ½" to 2" for Pressures up to 600 lbs
- Many Thousands in Service
- Sold by Nearly 150 Mill Supply Houses

See Your Supply House or Send for Bulletin S-201

YARNALL-WARING COMPANY
107 MERMAID AVE., PHILADELPHIA 18, PA.

YARWAY STRAINERS



Say goodbye TO PIPE WRENCH TROUBLES

RIDGID guarantee means no wrench housing repair cost—at all—ever!

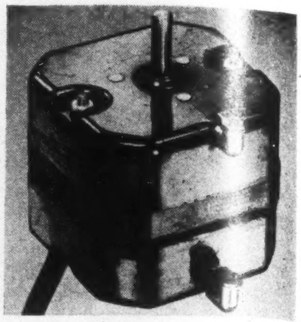
● RIDGID's unconditional guarantee protects you forever from wrench housing expense and bother. And that's not all. The powerful I-beam handle, instant action non-slip jaws, handy pipe scale on hookjaw and free spinning adjusting nut *all* make for faster, easier work . . . saving both effort and time. Millions of enthusiastic users specify RIDGID wrenches. You'll prefer them, too. Sizes from 6" to 60" available at your Supply House.

Handy end wrench for pipe in coils or on flat surfaces.

UNCONDITIONAL GUARANTEE
If this Housing ever Breaks or Distorts we will replace it Free
COPR 1937
THE RIDGE TOOL CO.
ELYRIA, O.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY · ELYRIA, OHIO

Shaded Four Pole Design Used in Small Induction Motor

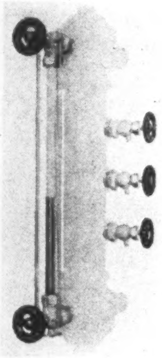


No. 3710—The new "Raytheon" type 300 motor, offered by Russell Electric Co., 340 W. Huron St., Chicago 10, Ill., is said to combine high starting torque with high efficiency and flexibility.

A low external field is realized by the large amount of iron contained in its core, and a dynamically balanced rotor, kept accurately centered and aligned by a rabbeted 3 in. square stator, assures quiet operation, according to the manufacturer. "Oilite" bearings with large oil reservoirs, precision oil slingers, and two internal cooling fans are also design features.

With horsepowers ranging from 1/150 to 1/40 and starting torques as high as 10 oz-in., the motor is available in open or totally enclosed construction, for vertical or horizontal operation, on 50, 50/60, and 60 cycles, at any voltage up to 250.

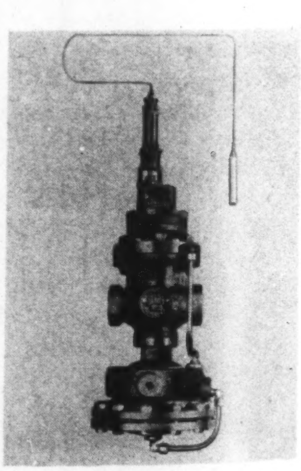
Boiler Water Gages and Cocks Designed for High Pressure



No. 3711—High pressure water gages and gage cocks are available from Swift Lubricator Co., Inc., Elmira, N. Y.

Maximum working pressures are marked on each fitting as required by boiler codes. The No. 160 gage and No. 196 gage cock are available in ⅜, ½, and ¾ in iron pipe thread sizes. The gages have stems which are designed to be self cleaning and are shipped complete with packing and any length gage glass and guards. The cocks are also shipped complete with packed stuffing box. The soft metal seat is a special alloy, said to give positive shutoff and long life.

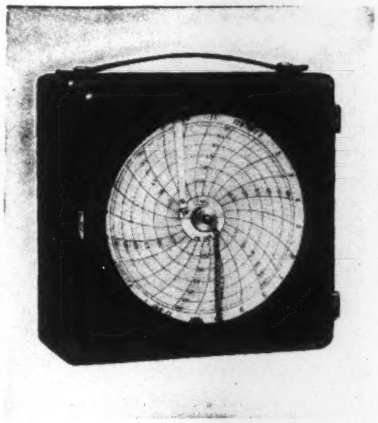
Develops Self Acting Temperature Regulator



No. 3712—Leslie Co., 51 Delafield Ave., Lyndhurst, N. J., has developed a new self acting, temperature regulator designated as Class T.

Features are said to include single seated construction in all sizes from ½ to 4 in. for steam pressures up to 125 psi and temperatures to 450 F, a packless main valve stem, the use of a hard faced seating surface and hardened wearing parts, and a liquid filled thermostatic element, all of which are designed to assure positive control response to small temperature changes, positive dead end shutoff, long life, and simple maintenance.

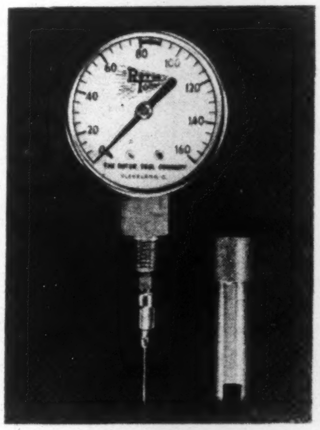
Portable Temperature Recorder Offered for Many Uses



No. 3713—A miniature size temperature recorder, designed for use in many applications where a shock resistant, portable temperature recording instrument is necessary, has been announced by the C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn 5, N. Y., a subsidiary of Portable Products Corp.

The new instrument is said to be particularly suitable for use in trucks, railroad cars, and airplanes in transit, as well as in other operations where vibration is encountered. Because of its small size and portability, it is also recommended for checking refrigerating, heating, and air conditioning equipment. The instrument is available in two forms: the single pen unit for recording temperature only, and the two pen temperature and time operation recorder which charts the running time of refrigeration motors in addition to recording temperature. It is available in a wide variety of ranges, and the chart drive is a seven-day spring propelled mechanism with charts of 24 or 72 hr duration.

Needle Gage Shows Pressure at Air Tools



No. 3714**—The Rotor Tool Co., 17325 Euclid Ave., Cleveland, Ohio has announced a new needle type pressure gage, the MSK-55, designed to show the actual air pressure at an air tool in operation.

A hollow needle (hypodermic type) with a sharp tapered point is secured in an adapter which fits onto a taper on the base of the air gage which is inserted in the air hose, so that it shows the pressure at the tool while it is under full load. This pressure, on account of restrictions in the air line, fittings, or hose, may be entirely different from that shown at the compressor.

Acquires Manufacturing Rights to Pipe Couplings, Swivel Joints

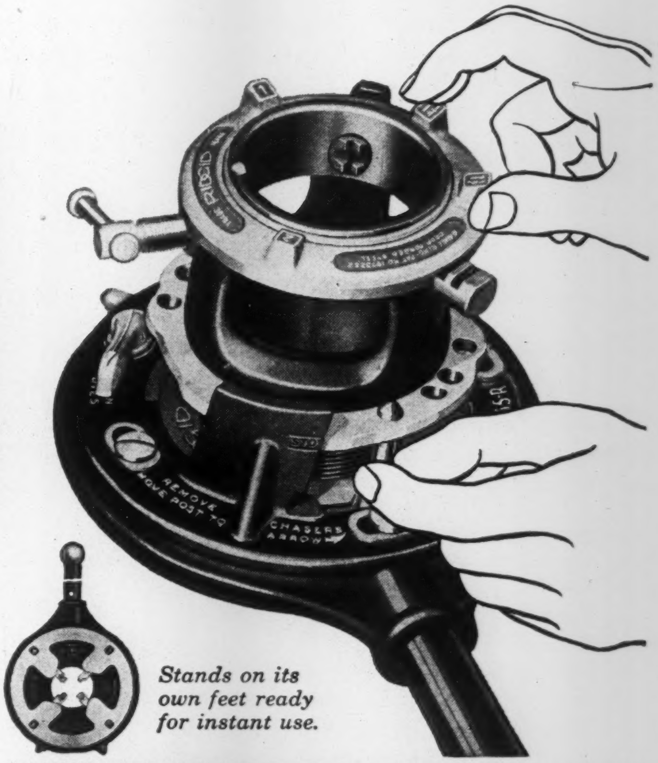
No. 3715**—Hinderliter Tool Co., Div. of H. K. Porter Co., Inc., Tulsa, Okla., has acquired all manufacturing rights for "Nail-It" pipe couplings, mud guns, swivel joints, and pump suction couplings.

The manufacture of these products is under way at

Perfect
PIPE THREADS
IN RECORD TIME

RIDGID No. 65R is ready to thread 1" to 2" pipe in a mere 10 seconds!

● Here's a rugged pipe threader that's really fast and easy to work. Sets to size in 10 seconds to thread 1," 1¼," 1½" or 2" pipe. Workholder sets instantly —only one screw to tighten, no bushings. RIDGID No. 65R is self-contained—no dies to haul around or lose; one set of tool-steel chaser dies gives you accurate threads on any kind of pipe or conduit . . . with surprisingly little effort. Every No. 65R is factory-tested. Buy from your Supply House.



Stands on its own feet ready for instant use.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

ACCURATE

TEMPERATURE INDICATION

50
100
150
200
250
300
350
INDUSTRIAL THERMOMETER

Model F-1 Indicating Thermometer, priced from $22. Other styles & types available. Send for catalog.

The large, easily-read dial on this Auto-Lite Indicating Thermometer simplifies temperature observation. Equipped with flexible capillary tubing, readings can be made at convenient distance from the temperature source. The pointer is connected directly to the bourdon spring for accurate, efficient one-to-one ratio movement. Sturdy construction eliminates delicate parts. Choice of standard chart ranges.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION • TOLEDO 1, OHIO
New York Office: Chrysler Building • Chicago Office: 600 S. Michigan Blvd.

AUTO-LITE

INDICATING & RECORDING THERMOMETERS

the Hinderliter's Tulsa works under the new trade name of "Nail-It-Kwik."

This new coupling principle and sealing method is said to be the fastest type of coupling yet devised. The halves of the unit are coupled by driving common nails into mating grooves in the male and female ends and are uncoupled by merely pulling the nails. Two or more nails are used on each coupling to form a removable steel shear ring.

Oil and wear resistant synthetic "O" ring gaskets are used to form pressure tight seals.

Small Check Valve is Piston Operated, Spring Loaded

No. 3716—The Pokorney Mfg. Co., 3117 Clybourn Ave., Chicago, has announced a new spring check valve, series 1000, for use on air compressors, gas pumps, water, air, oil, or gas lines (including butane and propane). Piston operated and spring loaded, this new valve is reported to operate with a minimum of noise providing a positive nonleaking check.

The valves are cast from bronze and, after machining, each is individually tested. They are available in ⅛, ¼, ⅜, ½ and ¾ in. IPS screwed ends. Larger sizes will also be available.

Electronic pH Meter Operates on A-C Current

No. 3717—The new electronic pH meter developed by Photovolt Corp., 95 Madison Ave., New York 16, N. Y., is designed for both laboratory and industrial applications and for all types and designs of electrodes for pH, titration, and oxidation-reduction potentials.

It is used with a-c power, 90 to 275 volts, 50 to 60 cycles. The indicating meter is equipped with a 7 in. scale and mirror for convenient reading and high precision. The unit covers the complete pH range, with no reversal switch required. It is standardized with the aid of a single buffer solution and a single control knob, and temperature correction charts are not used because the temperature control range is from 0 to 100 C.

Steel Construction Used in Centrifugal Fans

No. 3718—"Health-Aire" centrifugal blowers for ventilation and air conditioning use have been announced by Johnson Fan & Blower Corp., 1319-25 W. Lake St., Chicago 7, Ill.

Blowers are available in a wide range of sizes (from 4 to 47 in.) in single or double width and are of the forward curved blade type. Outstanding characteristics are said to include economical, quiet, and trouble free operation. Steel construction is used throughout.

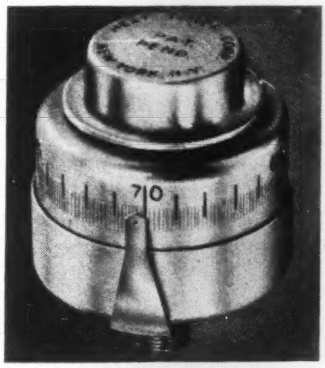
Times the Operation of Spot Welding Machines

No. 3719*—The No. 52D "Timatron" electronic welding timer is designed to eliminate guess work in spot welding by giving precision control to the flow of current in timing the weld. Once set for a particular thickness of metal, timing is said to be automatic throughout the entire production run. The manufacturer is Ripley Co., Inc., Middletown, Conn.

The device is designed for simple and inexpensive installation on all types of spot welding machines. It has the capacity to time any machine up to 10 kva, and is adjustable from 0.1 to 5 sec by a hand control covering any timing range which may be desired. The dial, which adjusts the timing period, is calibrated so that adjustment can be made quickly when switching from one thickness of metal to another.

Increased production, elimination of spoilage, and reduction in fatigue are said to be outstanding advantages.

Thermostat Controls Steam Radiator Air Vent



No. 3720*—A steam radiator valve designed to control automatically the temperature of each radiator on which it is installed has been developed by the Heat Timer Corp., 160 Fifth Ave., New York City.

In appearance the valve is much like any other radiator air vent, although somewhat smaller in size. Etched on its cylindrical side is a scale of temperatures, ranging from 55 to 80 deg. The valve is installed in place of the ordinary air vent and is designed to discharge air only when the temperature within the room falls below the indicated setting. This, says the manufacturer, allows steam to enter the radiator until the desired room temperature has been reached, at which point steam is withheld until a drop in room temperature again opens the vent and the cycle is repeated. The device is offered for any one pipe steam system.

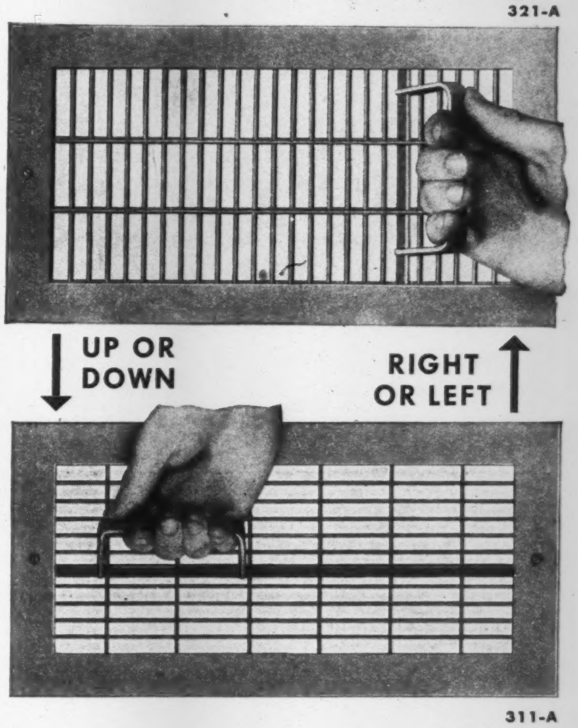
Equipment Shorts

Voluntary dissolution of the committee representing creditors of General Engineering and Mfg. Co., St. Louis, has just been announced by William T. Sutter, Westinghouse Electric Corp., chairman of the committee. This action comes as a result of the rapid progress made in the company's financial and sales pictures under the direction of Norman B. Schreiber, who was brought into the organization last August as board chairman and general manager. Under the new regime, the manufactured inventory of "Gemco" air conditioners has been substantially reduced, the distributor organization has been tripled, and the financial status so improved that creditors and the St. Louis banks who have been working with "Gemco" officials agreed unanimously that committee services are no longer needed. Schreiber will remain with the company as chairman and general manager, it is stated.

INDEPENDENT

"Fabrikated" WALL GRILLES
for Commercial Installations

PROVIDE ADJUSTABLE DIRECTED AIR FLOW



Made to fit openings in even inches from 8" x 4" to 60" x 40"

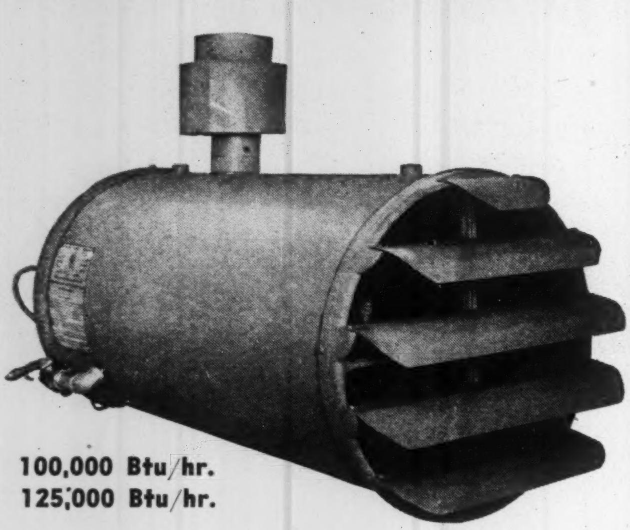
Independent Fabrikated* Adjustable Grilles (patented), rigidly constructed with stamped steel rims and steel bars, are made with either vertical or horizontal grille bars. Grille bars are *adjustable* before or after installation; available also with bars permanently set for straight flow.

Write for new Catalog No. 48—gives schedule of sizes, details and prices.

Always Leading — Always Progressing

*Reg. U. S. Pat. Off.

THE INDEPENDENT REGISTER CO.
3747 E. 93rd STREET · CLEVELAND, OHIO



100,000 Btu/hr.
125,000 Btu/hr.

It's New!
It's Amazing!

This John Zink
UNIT HEATER

This new and unique design in suspended space heaters features: More Head Room—Compact design—More Heat from gas burned, gas company test shows overall efficiency of 82%.

Where floor space is at a premium this turbine type unit has greater heating capacity. Controls are built-in. Unit is shipped completely assembled ready for installation. One unit will heat a 40′ x 80′ space. It is A. G. A. approved for liquefied petroleum gases, manufactured or natural gas.

- **Finished in Toast Tan Crinkle Enamel Baked On**
- **Adjustable Louvers**

— Write for Literature —

John Zink Company
4401 South Peoria
TULSA, OKLAHOMA

New York - Salt Lake City - Houston - Los Angeles

Equipment Shorts (Cont.)

The first centrifugal compressor for handling propane on shipboard, complete with turbine and already mounted on a steel base, has been shipped by Carrier Corp., Syracuse, N. Y., to Warren Petroleum Corp., Beaumont, Tex. The 1270 hp unit occupying less than 63 sq ft of deck space will be used aboard a unique tanker that will transport propane in liquid form from the Texas fields to the New York City area. The compressors will be used in unloading operations. When liquid propane is removed from the ship's tanks, the resultant pressure drop is said to convert about 266,000 lb of each load into gas. The compressor will be used to evacuate this gas and deliver it to a condenser for a return to liquid state.

Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., has opened a new district office at 922 Dermon Bldg., Third and Court Sts., Memphis, Tenn. According to a recent announcement, the opening of this new office marks the third move of a similar nature since the first of the year. Other offices have been established at Denver and Salt Lake City.

According to a recent announcement, the firm name, Zallea Brothers and Johnson has been changed to Zallea Brothers. The address remains the same, Taylor and Locust Sts., Wilmington 99, Del., and no change has been made in the company's line of expansion joints and flexible connectors.

While announcing the details of a new, intensive distribution program for its air conditioning line, Westinghouse Electric Corp. has reported plans to more than double its production of this equipment in 1948. The decision to expand manufacturing schedules is based on estimates of the continuing high demand for both comfort and industrial process air conditioning products and systems, according to A. J. Bronold, who heads the air conditioning activities in the Sturtevant division.

The Fitzgibbons Boiler Co., Inc., New York, recently honored 50 employees for their long terms of service at a dinner held in Oswego, New York, home of the company's plant. Continuing a practice instituted last year at the company's 60th anniversary celebration, emblems designating 25, 20, 15, and 10 year service were presented to the honored employees. The presentations were made jointly by Homer Addams, chairman of the board, P. K. Addams, president, and R. C. Malvin, vice president and general manager.

Petroleum Heat & Power Co. has recently placed in service a new airplane to facilitate more frequent contact between the home office in Stamford, Conn., and branches, field representatives, and distributors throughout the country. It is in constant use by administrative personnel, sales executives, and staff engineers who have field assignments and replaces a smaller one which the company operated for 30,000 miles last year.

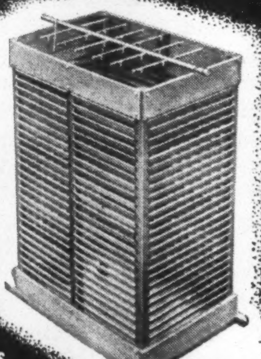
Producing three 110 in. radius arcs in Spang-Chalfant 12 in. carbon steel seamless pipe of 0.406 in. wall thickness, Shaw-Kendall Engineering Co., Toledo, Ohio, pipe fabricators, report that the resulting 31 ft 3½ in. high bend is the largest ever produced in its shops. The pipe, bent by a special process, will be used for steam distribution lines in a power plant at the University of Illinois. The Toledo firm states that this process uses no filler, utilizing instead the application of heat to the inside of the tube. After assembly the bend was disassembled into three parts to facilitate shipment.

A series of five day regional air conditioning schools, geared to the company's expansion program, has been conducted by Frigidaire Div., General Motors Corp., Dayton, Ohio. The fundamentals of air conditioning, including such phases as theory, air distribution, determination of refrigeration loads, selection of equipment, product application, and installation were covered for the benefit of district and dealer engineering personnel.

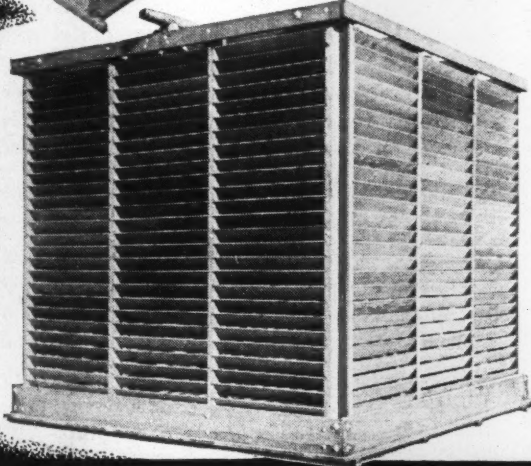
Cochrane Corp., Philadelphia, manufacturer of water conditioning and steam handling equipment celebrates in 1948 its 85th continuous year in the power plant equipment field. The company's predecessor, Harrison Safety Boiler Works, was founded in 1863 to build a cast iron boiler constructed of sections held together by tie bolts. In 1880 David Cochrane, foundry and shop foreman, developed what is said to be the first practical oil separator for cleaning exhaust steam. This in turn, says the company, led to the first open feedwater heater, and in 1900 the commercial application of heat as an aid in water softening was introduced. Over the years, various types of heat recovery systems and other related steam specialties have been developed.

First color motion picture to show the production of aluminum from raw bauxite to finished products, Pigs and Progress, has been released by Reynolds Metals Co., 2000 S. Ninth St., Louisville, Ky. The 16 mm picture is in sound and full color and is said to represent one of the first attempts to carry nontechnical persons behind the scenes and to give them in simple language an insight into the many processes through which bauxite goes before emerging as metallic aluminum. The picture is being made available without charge for showing before interested groups.

Formation of Aminco Refrigeration Products Co., to take over the refrigeration division of American Injector Co. has recently been announced. The new company has moved into quarters at 14544 Third Ave., Detroit 3, where it will maintain offices, manufacturing and shipping facilities, and conduct developmental work. The guarantees and warranties on the American Injector line will continue in force without interruption. Products manufactured will include oil separators, high side floats, water valves, snap action valves, constant pressure valves, strainers, check valves, and other specialties.



SERIES 100



SERIES 200

Engineered Economy in

ATMOSPHERIC SPRAY TOWERS

Marley Atmospheric Spray towers are doubly economical: economical to install, economical to operate *efficiently* . . . because, regardless of price, every Marley tower is engineered for efficiency. Only years of experience and constant study can produce towers with these qualities so vital to efficient atmospheric water cooling:

- **Most complete utilization of natural air flow.**
- **Minimum drift loss.**
- **Balanced spray system gives maximum distribution at lowest pressure.**
- **Sturdy structural strength without excess usage of material.**

SERIES 100 TOWERS—Produced in 6 frame sizes for small capacity installations.

SERIES 200 TOWERS—Built in standardized sections for variable capacities. Standard coils are available for closed system cooling. Both towers are prefabricated for ease of erection.

MARLEY WAY is the PERFECT SPRAY

Marley Non-Clog Spray Nozzles set the standard in process industries for product and container washing, humidifying, cleaning, air washing, homogenizing and other services.

MARLEY COOLING TOWERS

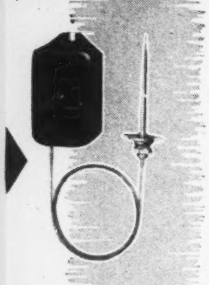
THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS

BARBER COLMAN

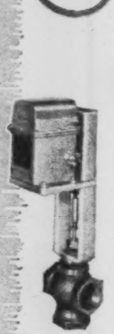
Control Systems for . . .

HOT WATER HEATING

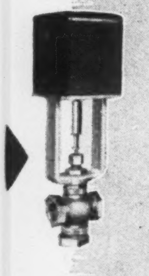
Thermostatic Adjuster with outdoor bulb compensates for changes in outdoor temperature.



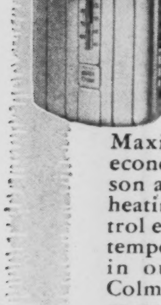
Hot Water Microtherm controls water temperature and is reset by Thermostatic Adjuster.



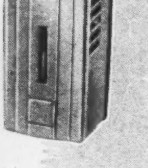
Motor-Operated Mixing Valve, controlled by Microtherm, governs water temperature.



An alternate type of Motor-Operated Three-Way Mixing Valve controlling water mixture.



High Limit Room Microtherm, which can be used in conjunction with other controls.



High Limit Room Thermostat prevents high room temperature by stopping the circulator.

Maximum comfort and maximum economy throughout the heating season are achieved best, in a hot water heating system, with automatic control equipment which varies the water temperature in proportion to changes in outside temperature. Barber-Colman offers an extensive range of control systems adaptable to all types of hot water heating installations such as ceiling panels, radiators, wall panels, blast coils, convectors, floor panels, unit heaters, baseboard panels, and others.

WRITE FOR LITERATURE . . .
Ask for Bulletin F-3157, which illustrates and explains the basic principles and applications of Barber-Colman Control Systems for Hot Water Heating.

BARBER-COLMAN COMPANY
1228 ROCK ST. • ROCKFORD, ILLINOIS
Automatic Controls for Heating and Air Conditioning

REPRESENTATIVES IN ALL PRINCIPAL CITIES

EXECUTIVE CHANGES

Due to the expanding operations of the Louis Allis Co., Milwaukee, three new offices have recently been created. Elected to these offices were Louis Allis, Jr., vice president in charge of sales, F. O. Kovich, vice president in charge of manufacturing, and T. R. Wieseman, vice president in charge of engineering. In addition to these elections, C. G. Skidmore has been named sales manager, J. H. Daganhardt, chief engineer, and J. J. Kirkish, chief of electrical design. The company is completing and moving into a new factory building and office. The new facilities are expected to provide a substantial reduction in overall costs through increased efficiency. The company builds integral horsepower electric motors exclusively, and according to President E. P. Allis, expects to operate at peak capacity in the foreseeable future.

F. H. Gaylord, vice president in charge of sales, Hoffman Specialty Co., Indianapolis, has announced the promotion of E. L. Malm from assistant sales manager to sales manager of the company. Mr. Malm has been in the heating industry since 1922. His experience has embraced engineering, territory sales, sales administration, and sales promotion. W. W. Dillon, who has recently been appointed assistant sales manager, has been with the company 19 years.

The newly appointed eastern sales manager of Pyle-National Co., Chicago, is T. J. Little, who will make his headquarters in Grand Central Terminal, New York City. During the war Mr. Little served for two years with the New York Ordnance District as chief of the conversion engineering section, production service branch, industrial division. Upon completion of this assignment he received the U. S. Army Ordnance Award for Meritorious Civilian Service. In 1945 he was on duty in Germany as chief of the nonferrous metal section, Office of Military Government.

The appointment of G. M. DeJarlais as service manager of the unit air conditioner division, Fedders-Quigan Corp., Buffalo, N. Y., has been announced by E. A. Bonneville, sales manager of that division. Mr. DeJarlais, who is developing a complete service and installation program, including distributor and dealer cooperation and training, is a graduate engineer and has had extensive experience in the electrical refrigeration and air conditioning fields.

Election of W. A. Roberts and W. C. Johnson, executive vice presidents of Allis-Chalmers Mfg. Co., Milwaukee, to the firm's board of directors has been announced by Walter Geist, company president. Mr. Roberts is in charge of the company's tractor division, while Mr. Johnson occupies a similar position in the general machinery division. The new directors succeed the late Dr. C. E. Albright and H. S. Falk, president of the Falk Corp. Mr. Falk had submitted his resignation because of the weight of other business.

Ernest Muehleck, president, Keasbey and Mattison Co., has been re-elected chairman of the board of governors of the Magnesia Insulation Manufacturers Association, Washington, D. C., according to a recent announcement by U. W. Smith, manager of the association. A. M. Ehret, Jr., president and treasurer of the Ehret Magnesia Mfg. Co., has been named vice chairman of the board of governors, while L. M. Cassidy, vice president, Johns-Manville Corp., was elected treasurer. Also elected to the board are R. S. King, president, Philip Carey Mfg. Co. and R. H. Chase, vice president and general manager, Plant Rubber and Asbestos Works.

Allegheny Ludlum Steel Corp., Pittsburgh, has announced recent appointments in its production, research, engineering, and sales staffs. The appointments include R. J. Bryan as plant manager of the Buffalo foundry, Dr. P. K. Koh as associate director of research in charge of tool and die steel and allied products, G. I. Bottcher as assistant chief engineer, and C. M. Binney as assistant district manager of the New York sales district.

J. T. Mascuch, president, Breeze Corporations, Inc., has announced a number of changes in the management of the Aldrich Co., Wyoming, Ill., manufacturer of oil burners and boiler-burner units. P. M. Stephenson has been named executive vice president and general manager. J. C. Read has been appointed assistant secretary and assistant treasurer, and E. L. Bedard will continue in the position of sales manager. Mr. Stephenson, before joining the Aldrich Co. last year, was president of Aircraft Standard Parts Co., Rockford, Ill., an affiliated company. Mr. Read was also connected with this affiliated company as controller, while Mr. Bedard has had extensive experience in the heating industry, including oil burner design and manufacturing.

Ned Sebring has been appointed director of purchasing, Redmond Co. Inc., Owosso, Mich., manufacturer of low range fractional horsepower electric motors. He joined the company in 1932 and has served as supervisor in the shipping, receiving, stock, material control, and planning departments. In 1939 he was named assistant to the director of purchasing, which position he has held until this latest appointment. He replaces Ralph Redmond, who has been named director of sales and and is also vice president and treasurer of the company.

C. S. Munson, formerly president of Air Reduction Co., Inc., New York City, has been elected chairman of the executive committee. He is succeeded by J. A. Hill, who becomes the fifth president of the company. W. C. Keeley, formerly vice president, was elected chairman of the newly created finance committee, and C. E. Adams remains chairman of the board of directors.

Research Products Corp., Madison, Wis., has promoted A. W. Brown to the position of assistant sales manager. Mr. Brown is wellknown in the industry for his work in sales supervision of the company's air filters. The company also manufactures grease filters, expanded fiber products, and water treating minerals.

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... and **Sight-lite** GRILLES

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STRONG* Traps
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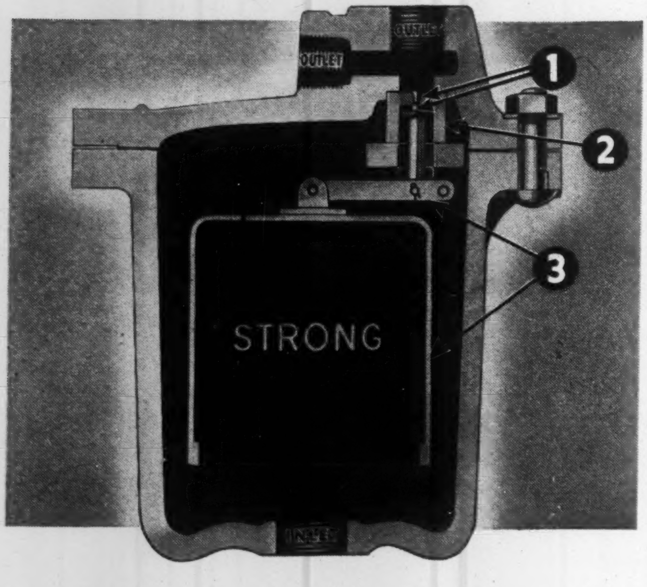

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1. **Anum-Metl Valve and Seat—guaranteed leakproof for one year;**
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STRONG 80 Series Trap sizes ½″ to 2½″, pressures to 250 lbs., temperature to 500°F. (forged steel for higher pressures).

Dual outlet simplifies piping, bottom inlet keeps trap cleaner. Years of trouble-free operation assured by super-STRONG construction.

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Executive Changes (Cont.)

C. H. Greenewalt has been elected the 10th president of E. I. du Pont de Nemours & Co., while W. S. Carpenter, Jr., has been elected chairman of the board. Mr. Carpenter's resignation as president and his designation as chairman of the board followed the retirement of Lammot du Pont from the latter post.

E. H. Horstman and Hans P. Dahlstrand have been named respectively chief engineer and director of engineering of the steam turbine department, Allis-Chalmers Mfg. Co., Milwaukee. Mr. Horstman, who has been with the company since 1923 and was formerly assistant chief engineer of the steam turbine department, assumes complete charge of steam turbine engineering. Mr. Dahlstrand has been associated with the company since 1904 and has held the positions of engineer-in-charge, chief engineer, and more recently consulting engineer of the company's steam turbine department.

G. J. Zimmerman, president, Strong, Carlisle & Hammond since 1940 and manager of its machinery division for more than a decade, has retired after 46 years of service. H. H. Smith, manager of the company's "Mac-it" division, has also retired after being with the firm for over half a century. E. L. Mack, with the company since 1935 and assistant manager of the machine tool division since 1946, will succeed Mr. Zimmerman as its new manager. S. C. Gunnett, formerly assistant to Mr. Smith, succeeds him as manager.

F. J. Nugent has joined Bryant Heater Co., Cleveland, as sales promotion manager. He is well known in the heating and water heating field, is first vice president of the Gas Appliance Manufacturers' Association, and chairman of the water heater section of that organization. He is also vice chairman of the electric water heater section of the National Electrical Manufacturers' Association. He attended Duquesne University and Carnegie Institute of Technology.

The policies and operations of a newly expanded service department of Lincoln Electric Co., Cleveland, will be under the direction of G. E. Tenney, who has recently been appointed service manager. To the task of creating an organization to handle the servicing of the company's arc welding equipment on a national scale, Mr. Tenney brings the experience of 15 years as district manager of the company's Chicago office. During the first World War he served for four and a half years in the Cavalry and Ordnance. He was a captain with the Coast Artillery on Corregidor for two years.

The appointment of P. G. Holliday as works manager of the Pyle-National Co., Chicago, has been announced by H. V. Engh, president. Mr. Holliday is a graduate of the University of Minnesota with a degree in electrical engineering and business administration.

J. A. Cortwright, general sales manager, Clayton Mfg. Co., El Monte, Calif., has announced the appointment of C. H. Garwood, Jr., as sales manager of the company's steam generator division. Expanding distribution, the development of new sales programs, and "dealer aids" for the assistance of distributors and field men are planned.

J. M. White, vice president in charge of manufacturing, Allis-Chalmers Mfg. Co., Milwaukee, has resigned but will remain in an advisory capacity to President Walter Geist for the next few months. Manufacturing operations will continue under the direction of F. S. Mackey, general works manager in charge of all general machinery plants, and H. W. Liebert, general works manager in charge of all tractor plants. Mr. White came to the company in 1929 after graduating from Alabama Polytechnic Institute. He was elevated to works manager in 1942 and became vice president in charge of manufacturing in 1944.

With the appointment of G. P. (Pete) Oldham as eastern division sales manager, Permanente Products Co., Oakland, Calif., has revealed the formation of two divisions in its nationwide sales structure. New York will serve as Mr. Oldham's headquarters for the management of Kaiser aluminum sales in the State of New York, the New England states, eastern Pennsylvania, Maryland, Delaware, Virginia, and New Jersey. R. C. Maentz will continue to serve as district manager for the New York district sales office. C. S. French, formerly manager of the company's Cleveland district sales office, has been named manager of the central sales division, with headquarters in Cleveland. C. S. (Chuck) Barnum, a veteran of more than 10 years experience in the aluminum manufacturing and selling fields, heads the company's Detroit district sales office. The new Salt Lake City branch sales office will be headed by Wayne Lake and will be under the jurisdiction of Jack Leslie, Oakland, Calif., district sales manager.

At the recent annual meeting of the Midwest Stoker Association, an organization of Chicago stoker distributors, wholesalers, and factory branches, F. J. Moran, sales manager, C. E. Sundberg Co., was elected president succeeding J. G. Beard, assistant manager, stoker division, Illinois Iron and Bolt Co. Mr. Beard had served as president since February 1946. Other officers elected were: vice president, E. W. Jones, officer manager, Iron Fireman Mfg. Co., Chicago branch; secretary-treasurer, J. W. Akins, Jr., regional manager, Anchor Div., Stratton and Terstegge Co. These officers were also elected to the board of directors along with Mr. Beard and E. J. Taft, vice president, Central Fuel Corp. It has also been announced that the Chicago Stoker Exposition, originally scheduled to be presented in downtown Chicago and jointly sponsored by the association and the Chicago Coal Merchants Association, has been indefinitely postponed.

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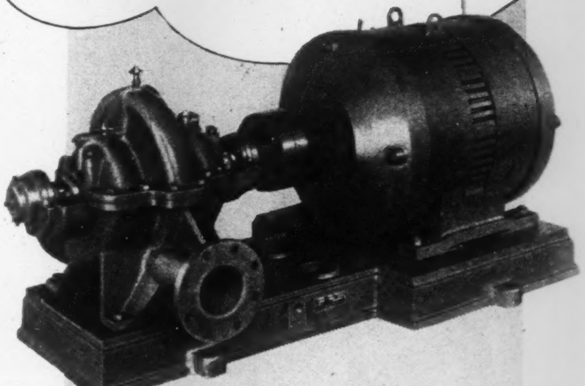
and ATMOSPHERIC CONDENSERS
use WEINMAN Centrifugal PUMPS!



TYPE "L" — 1 Split Case Centrifugal Pump, direct-connected to motor. For circulation of cooling water over Condenser Towers and Atmospheric Condensers. Worn parts can be replaced without disturbing or disassembling any pipe connections.
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WEINMAN pumps are designed and engineered by Centrifugal Specialists who KNOW THE AIR CONDITIONING FIELD and have applied this knowledge to pumps to do the job more economically and to give longer trouble-free service . . . quietly . . . dependably.

Weinman Centrifugal Specialists are AT YOUR SERVICE . . . TO GIVE SERVICE! They know the answers . . . if you have a pumping or pump installation problem just write, phone, or wire.

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The WEINMAN Pump Mfg. Co.
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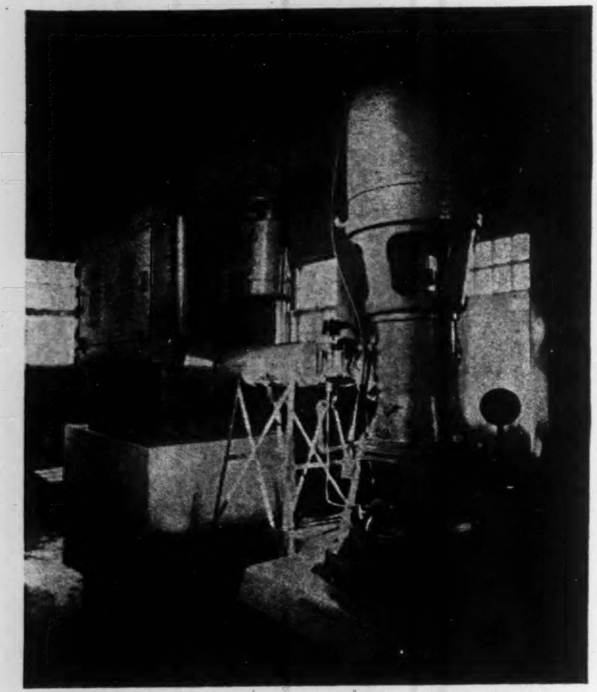


IN CASE OF Power FAILURE

The city of Margate, New Jersey no longer worries about an unforeseen powerline failure. Their newly installed million gallon per day Layne Well Water System is DUAL POWERED. Should the power fail and the electric motor "go dead" a big husky gasoline engine takes over to keep up water production.

Margate's new dual powered water system is a quality installation throughout with the very latest Layne developed control and engineering features. And like two other Layne installations for Margate—one of which is over 23 years old, this new unit will also give years and years of satisfactory operation.

Layne Well Water Systems whether installed for cities, factories, railroads, irrigation projects or other use, keep water production at the very lowest cost. Furthemore Layne associated companies constantly provide prompt repair and parts service for their Layne installation. For late catalogs, address Layne & Bowler, Inc., General Office, Memphis 8, Tennessee.

LAYNE WELL WATER Systems

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Pacific, Inc., Seattle, Washington ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Minnesota Co., Minneapolis, Minnesota ★ International Water Supply Ltd., London, Ontario, Canada ★ Layne-Hispano Americana, S. A., Mexico, D. F.

NEW BOOKS & REPORTS

Air Conditioning Properly Applied in Greenhouses Helps Plant Growth

The results of air conditioning in greenhouses, as obtained from research projects and as shown by the success of experiments on a commercial scale, indicate that environmental control systems should have wide application to many types of commercially important plants, in the opinion of L. C. Marshall, H. O. Eversole, A. J. Hess, and F. W. Went.

This conclusion is expressed in a paper, Technical Features of Greenhouse Air Conditioning, presented at the last annual meeting of the American Society of Refrigerating Engineers, 40 W. 40th St., New York City. The authors have conducted investigations and have worked in collaboration since 1931.

The paper leads off by tabulating the environmental factors most important to the growth of plants under two classifications; top or vegetation environment, and root environment. Under the former are included air temperature, relative humidity of the air, air movement, radiation, and gas content of the air (carbon dioxide, oxygen, and other constituents). In the latter group the authors include the growing medium, root temperature, plant nutrients, and soil moisture. Information is given on the optimum conditions for each of these factors with emphasis on the necessity for maintaining different temperatures and humidity conditions during the day as compared to night operation.

Some load calculations and the corresponding discussion point out that under many conditions the air conditioning load, in terms of the economics of greenhouse operation, is virtually prohibitive. A number of interesting methods of controlling or reducing the radiation load are discussed. These include filtering the infrared content of the solar spectrum, as this light lies beyond the range of photosynthesis, and using a sheet of flowing water on the greenhouse roof. Reductions in the radiation load are tabulated and detailed information is given on the type of water sprays used.

In regard to these and other factors such as air distribution and circulation, the maintenance of night temperatures, structural problems, root environment, and the gas content of the air, the methods proposed by the authors are intended only as a guide to those who may wish to make use of the new techniques, especially in research problems. Practical and detailed data are provided for these readers.

Finds Effective Methods for Reducing Galvanic Corrosion in Gas Water Heaters

Electrical insulating materials are effective in stopping galvanic corrosion, whereas the usual treatment with a complex calcium sodium phosphate for preventing internal corrosion of hot water storage heaters does not stop galvanic corrosion of dissimilar metals used in the same system. Magnesium is better than zinc for stopping galvanic corrosion couples in beakers filled with water at atmospheric pressure. These are a few of the conclusions of Dr. Robert G. Weast, Case Institute of Technology, who prepared a report, Galvanic Corrosion of Dissimilar Metals as Applied to Gas Hot Water

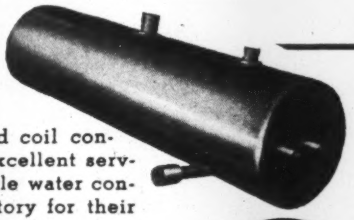
FREON SHELL and TUBE CONDENSERS

Cleanable

WITHOUT BREAKING WATER CONNECTIONS

● The efficient operation of Acme shell and tube condensers for Freon and methyl chloride has long been recognized throughout the industry. Shells of seamless steel tubing eliminate possibility of leaks that could occur in welded shells. "All-in-one" finned tubing, one piece of metal, assures maximum heat transfer efficiency. Removable heads make them cleanable. Tubes are replaceable. STANDARD model capacities up to 120 tons—SENIOR models up to 460 tons.

On SENIOR models the heads are "through bolted" to the tube sheets and are cleanable without breaking water connections. Write for complete information—Catalog No. 23.



● Acme shell and coil condensers supply excellent service where available water condition is satisfactory for their application. Shells of seamless steel tubing closed and sealed on both ends. Copper condenser coil. Sizes up to 8 tons. Write for Catalog No. 224.

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Evaporative Condensers	Forced Convection Units
Ammonia Condensers	Pipe Coils
Freon Condensers	Heat Interchangers
Dry-Ex Water Coolers	Oil Separators
Flooded Water Coolers	Liquid Receivers
Hi-Peak Water Coolers	Heat Exchangers

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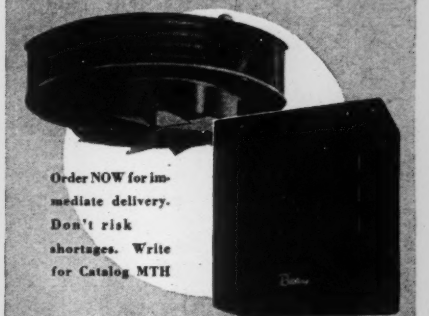
MAGNA-Therm UNIT HEATERS



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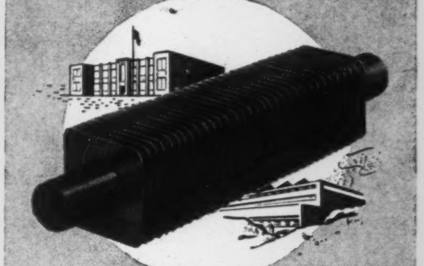

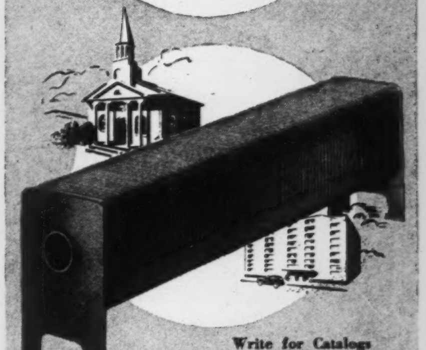

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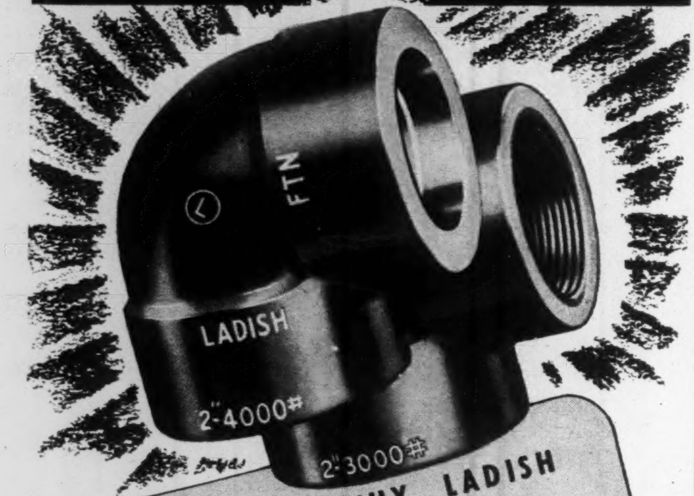

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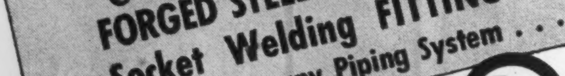

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Storage Heaters, Part I, for the American Gas Association.

The study, sponsored by the AGA committee on domestic gas research, is being made to eliminate the problem of tank failures caused by stray electric currents. This first report deals primarily with results obtained from small scale tests, summarizes 10 factors resulting from the initial work, and discusses a method which has been developed to accelerate conditions in open beakers so that certain tests can be made quickly.

The 23 page report, 8¼ x 11 in., and paper covered, is available from AGA headquarters, 420 Lexington Ave., New York City. Other reports will be published as the study progresses.

Uses Owning, Operating Costs for Comparing Centrifugal Compressor Refrigerants

Since 1922 when the first centrifugal refrigeration machine was installed, much progress has been made with the resultant popularity of these units for the larger installations. Not the least of the improved items is the refrigerant, and ammonia, "Dilene," "Carrene," "Freons 11, 12, 113, and 114," water, methyl chloride, ethylene, butane, propane, sulphur dioxide, and isobutane are the refrigerants which can be and have been used.

In a paper, Choice of Refrigerants for the Centrifugal Compressor, preprinted by the American Society of Refrigerating Engineers, 40 W. 40th St., New York City, O. E. Gammill, Jr., Carrier Corp., compares a low pressure refrigerant, "Freon-11," and a high pressure refrigerant, "Freon-12," on the basis of owning and operating costs.

In discussing the centrifugal cycle, the author briefly covers the formula for the calculation of brake horsepower, compares the design and construction features of "Freon 11 and 12" units insofar as they are affected by the properties of these two refrigerants, and points out that there is little difference between the cycles of the reciprocating and centrifugal machines other than the method of compression and the fact that there are two heat loads; the load of cooling the water or brine and the load of cooling the liquid refrigerant from its condensing temperature to the economizer temperature. (Because the centrifugal unit may compress the refrigerant in several stages, it is possible to flash cool some of the liquid before it enters the cooler at a higher temperature, thus saving horsepower.)

In setting up a basis for comparing owning and operating costs, only first cost, brake horsepower per ton, hours of operation, loss of refrigerant, and development and manufacturing charges (depending on the number of units sold) are taken into consideration. Other costs such as maintenance and space requirements are ignored since they are approximately the same for either refrigerant. Tabulated data and charts are used to compare the owning and operating costs of a single wheel "F-12" unit and a two wheel "F-11" unit, a two wheel "F-12" and a three wheel "F-11" compressor, and a two wheel "F-11" unit and a two wheel "F-12" compressor. Cross-over points on the curves are of interest as they show how cost and power rate affect the hours of operation to give economic balance.

Mr. Gammill concludes that the economic advantages of one refrigerant over another are rather small and that the dependability of equipment against refrigerant

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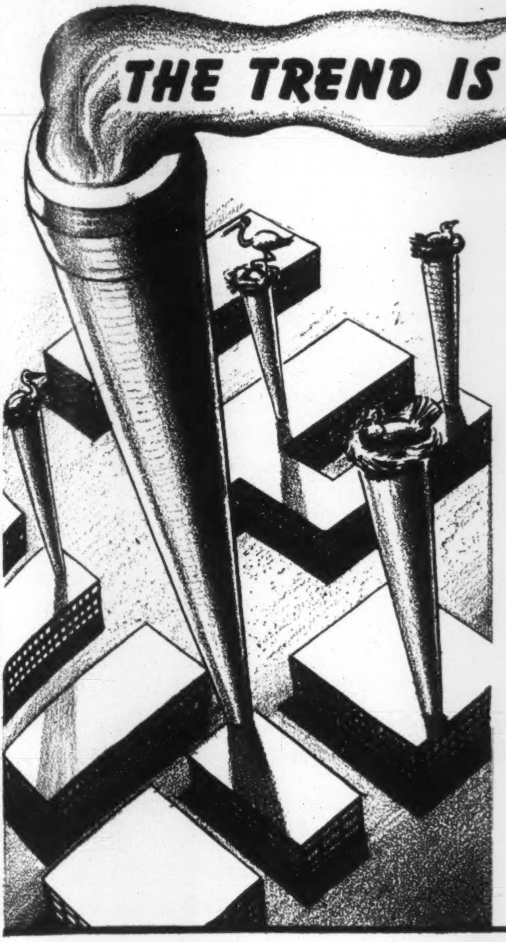

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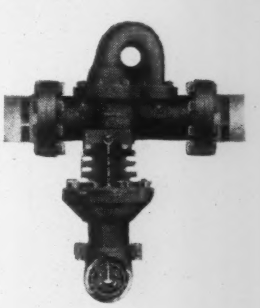
Modern central heating plants not only reduce the smoke nuisance — they deliver ample steam at all times, economically, dependably. But with ample steam available at the turn of a valve, accurate metering of all distribution lines becomes a "must". Builders Shuntflo Meter is ideal for this service . . . it eliminates guesswork — shows exactly where and *how much* steam is being used. It provides accurate totals in pounds or cubic feet — meters steam consumed by individual departments, processes or buildings, over an unusually wide range of flow. The Shuntflo Meter is entirely self-contained, requires no electricity, has no clock to wind. It is installed in any line up to 12" as easily as a valve. For complete information and Bulletin 349, address Builders-Providence, Inc., (Division of Builders Iron Foundry), 41 Codding Street, Providence 1, Rhode Island.



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Streamlined Flow Circulates More Water At Less Friction Pressure

The flow of water is intercepted and directed through the tube into the branches for a 100% streamlined diversion

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Each Branch Size of Flo-Master Can Be Installed In Any Size Main—Costs No More Than Stationary Shunt Fittings.

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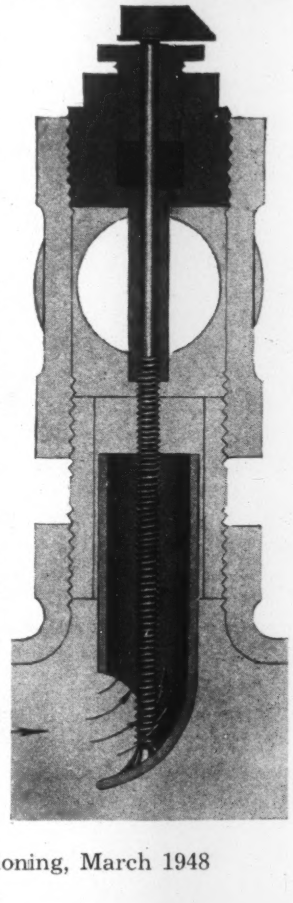

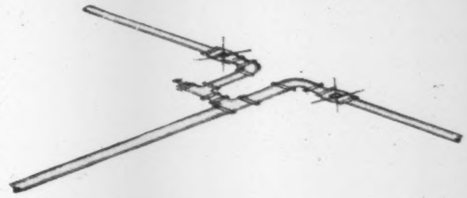

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THE ZONE-MASTER for automatic temperature control
THE FLO-MASTER for manual temperature control

Built with the PATENT adjustable streamlined interceptor tube supported by a long threaded adjusting rod for manual regulation during circulation for balanced temperatures

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FLOW TO BRANCH MAINS ELIMINATING PLUG COCKS
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MASTER FLO-CONTROLS ARE THE FIRST TO REGULATE THE FLOW AS A VOLUME STREAMLINE DAMPER CONTROL — NOT AS VALVES BUILDING UP BACK PRESSURES

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OIL-FIRED UNIT HEATERS

"Up in the Air and Out of the Way"

WANT to cut new construction costs? Want to "add" 50, 100, even 200 feet of floor space to existing facilities? Then best you get acquainted with SHAFCO Suspended Oil-Fired Unit Heaters. They "hang" overhead . . . up in the air and out of the way . . . leaving space below free for useful, profitable occupation. And talk about heating efficiency! SHAFCO is tops! . . . 85% by actual tests . . . due to its exclusive, patented "counterflow" principle of air and heat. Installation? Quick and easy . . . because SHAFCO Heaters are compactly designed, simply assembled. Built-in plenum chamber eliminates makeshift "on-the-job" finishing. Heavy duty blower unit assures efficient heat circulation with minimum duct-work. Long-lasting? You bet! SHAFCO maintains the highest standard of quality throughout . . . with heavy gauge steel construction that really stands up under heat. No strains, no warping, no buckling! And SHAFCO Heaters have been thoroughly proved in use over 10 years successful application by major oil companies.

Models available from 100,000 to 400,000 B.T.U. to meet heating requirements of a wide range of commercial and industrial installations. Write today for the complete SHAFCO story.

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loss and breakdown, together with all around performance are the essential requirements.

Studies Design Methods for Resisting Gas Pilot Stoppage Due to Dust and Lint

The operation of any automatic or semi-automatic gas appliance depends upon the satisfactory operation of its pilot burner. In dust laden atmospheres gas appliances may become inoperative because of improper pilot burner operation. This has been the subject of a study by the American Gas Association.

A report, Research Bulletin No. 46, Research in Design Methods of Preventing Closures of Gas Pilot Burner Primary Air Openings by Dust and Lint, has been issued by the AGA testing laboratories. Variations in size and position of primary air openings, burner tube diameter, shields, and other protective devices are discussed. A recently developed incinerator type pilot burner was constructed and its performance is compared to that of conventional pilots. Pilot burners drawing all of their primary air from the main burner head or burner venturi are also described as a possible solution to the problem.

The 28 page, paper covered report, 8½ x 11 in., may be obtained from AGA headquarters, 420 Lexington Ave., New York City.

Other Books and Reports Received

Development of the Heat Pump, by E. B. Penrod, professor and head of the department of mechanical engineering, University of Kentucky. Designated as Engineering Experiment Station Bulletin, Vol. 1, No. 4 and published by the college of engineering, University of Kentucky, Lexington, Ky. Contains information on the theory of the heat pump and data on installations prepared by the author and previously published. New material includes an analysis of performance characteristics using the earth as the heat source. The bibliography contains over 200 references to books, magazine articles, and other sources of information on the heat pump. It is paper covered, 6 x 9 in., and contains 78 pp.

Principles of Refrigeration, by W. H. Motz. This third and revised edition contains 672 pp., 6 x 9 in., 215 illustrations, 103 tables and is published by Nickerson & Collins Co., 435 N. Waller Ave., Chicago 44, Ill. The text is clothbound and is priced at $8.00. As free as possible from mathematics, the book is designed for beginners in the study of refrigeration. It presents elementary and fundamental principles underlying the operation of ice making and refrigeration machinery, the properties of refrigerants, and applications of refrigeration equipment.

Report No. 1086 on Automatic Gas Storage Water Heaters, published by the American Gas Association, 420 Lexington Ave., New York 17, N. Y. Recommends separate research to obtain technical data which could be used to attain a minimum practical fluctuation in hot water temperature. The report reviews the literature presently available on the subject.

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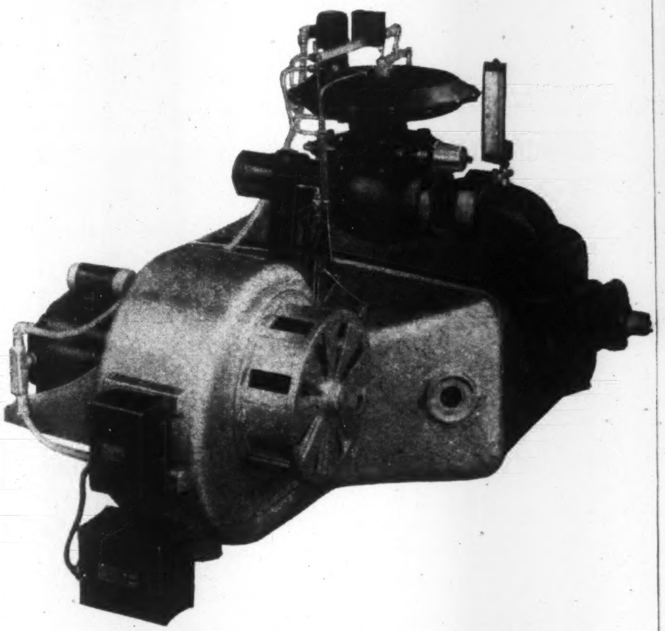
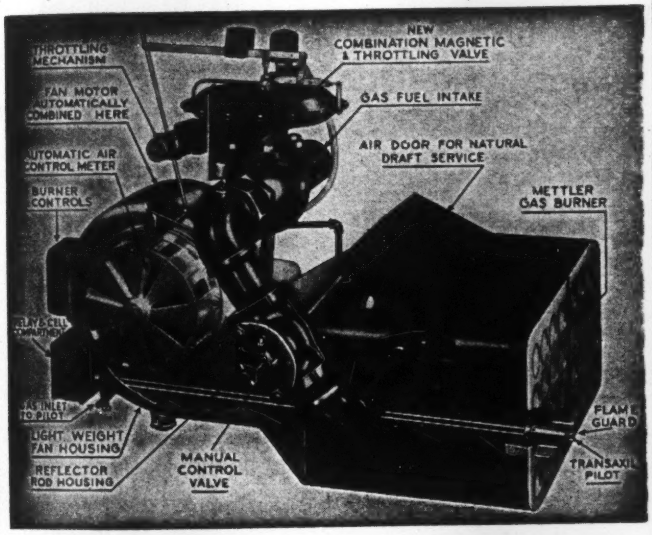
The Mettler "FAN-AIR" Gas Burner

LATEST MODEL FEATURES NEW AUTOMATIC SAFETY PILOT and TRIPLE CONTROLS



HERE IS A "FRONT VIEW" OF FAN-AIR GAS BURNERS (COMPACT AND SIMPLE)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Lower picture reveals essential and highly desirable POINTS of FAN-AIR MECHANICAL DRAFT GAS BURNERS. Not just a gas burner but a COMPLETE AND FULLY AUTOMATIC BURNER SYSTEM, factory tested and ready for application when received. It comes to you complete as pictured with simple, dependable, automatic controls. No other burner so easy to install. Why be satisfied with less—when all these tangible advantages are so readily available. SIZES 5 TO 400 HP.

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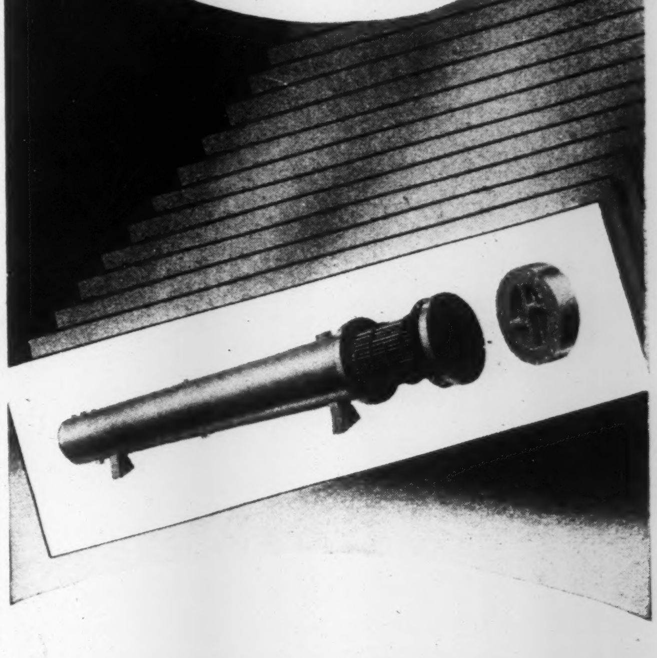

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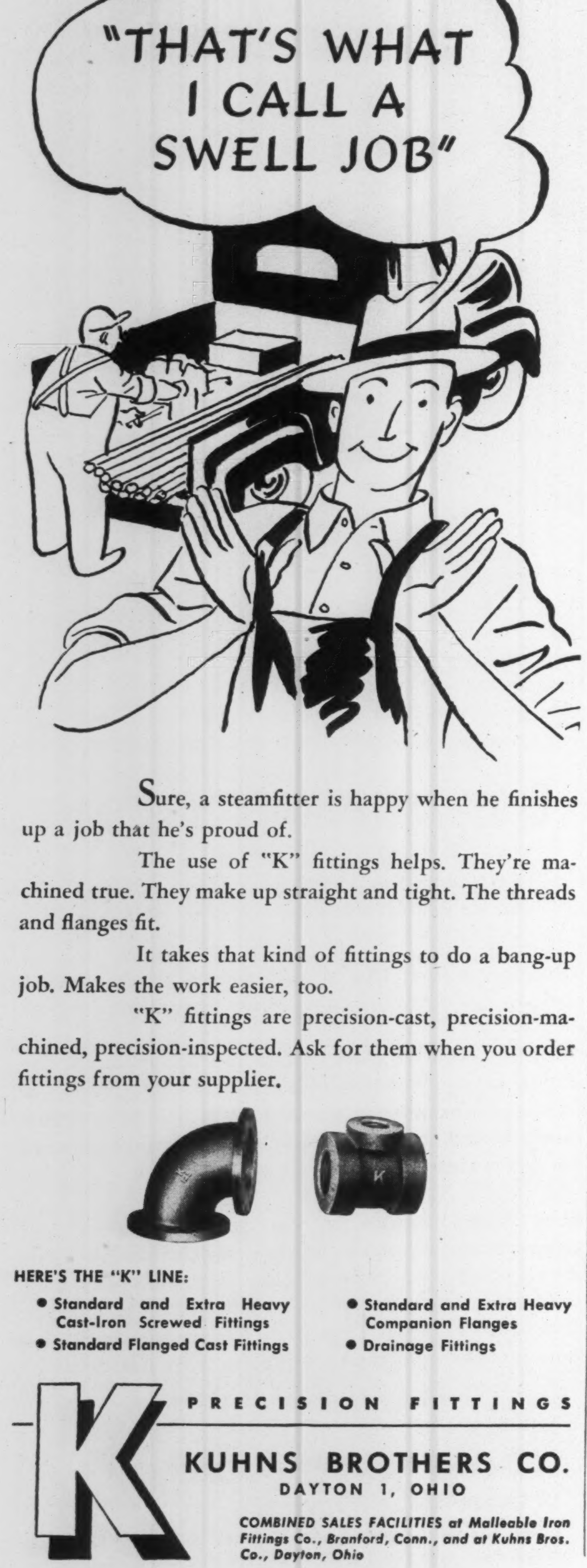

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MEETINGS & CONVENTIONS

New Jersey Engineers to Meet in Newark, Hold Exhibit

The New Jersey Society of Professional Engineers, 86 E. State St., Trenton 8, N. J., will hold its 24th annual convention, April 9 and 10, at Essex House, 1050 Broad St., Newark, N. J. The society, which numbers 5000 members, is planning a concurrent industrial, engineering, and commercial exhibit which will be used to present products, materials, and services in many engineering fields, including heating and ventilating.

Dr. Karl T. Compton to Address Foundrymen

Dr. Karl T. Compton, president of Massachusetts Institute of Technology, will be the guest speaker at the annual banquet of the 1948 convention and exhibition of the American Foundrymen's Association, 222 W. Adams St., Chicago. The convention will feature more than 60 sessions, including technical, general interest, and round table meetings, together with symposia, and lecture courses. The banquet is expected to attract 20,000 castings industry executives, technologists, and production men and will climax the five day meeting, scheduled for May 3 to 7. Philadelphia Convention Hall will be the scene of the exhibition.

Boston Section to be Host at ASRE Spring Meeting

The 35th annual spring meeting of the American Society of Refrigerating Engineers will be held May 31 to June 2, at Swampscott, Mass. Plans are now being formulated by the Boston section under the direction of O. C. Eckel, chairman of the convention committee. Society headquarters is at 40 W. 40th St., New York 18, N. Y.

I-B-R to Sponsor Second Short Course in Heating

A three day short course for the study of hot water and steam heating systems will be held at the University of Illinois, June 15 through 17. The course will be sponsored jointly by the university and the Institute of Boiler and Radiator Manufacturers. The type of instruction, to a large extent, will be similar to that given at the first short course, held at Navy Pier, Chicago, last September. This second short course will include both an elementary and an advanced course of study, the latter being intended for students who completed the first course. Subjects to be covered include heat loss calculations, blueprint reading, fuels and combustion, panel heating, baseboard radiation, and controls. Students will design and lay out various types of hot water and steam systems. Announcements of the course will be mailed by the extension division of the university to contractors, wholesalers, and others on the I-B-R mailing list in the middle western states, and reservations will be made in the order received. Requests for in-

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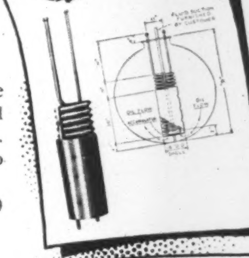

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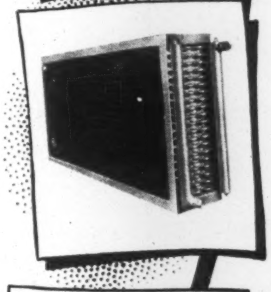

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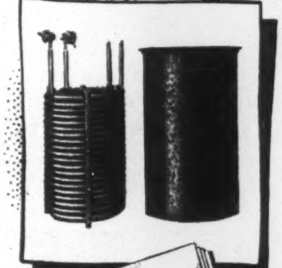

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Cash in on Peerless advertising and merchandising. Ask your nearest Peerless office to show you the Peerless Plan—for a Partnership in Profit in the Domestic Water Systems business.

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formation should be addressed to H. C. Rountree, assistant director, Division University Extension, room 118A, Illini Hall, University of Illinois, Champaign, Ill.

ASHVE Selects Bretton Woods for Semi-Annual Meeting

The Mt. Washington Hotel, Bretton Woods, N. H., has been chosen by the American Society of Heating and Ventilating Engineers as the scene of its 1948 semi-annual meeting which will be held June 21 to 23. Society secretary is A. V. Hutchinson, 51 Madison Ave., New York 10, N. Y.

Instrument Conference and Exhibit Scheduled for September

Plans are now under way for the Third Instrument Conference and Exhibit which will be held, September 13 to 17, at the Philadelphia Convention Hall. The conference and show are sponsored by the Instrument Society of America, 1117 Wolfendale St., Pittsburgh 12, Pa., with the cooperation of the American Institute of Physics, the industrial instrument and regulators committee of the American Society of Mechanical Engineers, and the instruments and measurements committee of the American Institute of Electrical Engineers. Technical programs of the cooperating societies are to be announced at a later date.

Program Being Arranged for AGA Convention

Arrangements for the 1948 convention of the American Gas Association, 420 Lexington Ave., New York City, are progressing rapidly. The convention will be held in Atlantic City, the week of October 4, with the technical sessions to be held at the Ambassador hotel, the residential gas section and the industrial and commercial section at the Ritz-Carlton hotel, and the accounting section at Haddon Hall. As a feature of the meeting, the Gas Appliance Manufacturers Association will hold what is said to be the largest exhibit of gas appliances ever held under one roof. Hotel reservation blanks will be sent to the entire membership in the near future.

Previously Announced Meetings and Conventions

National Association of Corrosion Engineers, 67 Wall St., New York 5, N. Y.—fourth annual conference and exhibition, April 5 to 8, Jefferson hotel, St. Louis, Mo.

Oil-Heat Institute of America, 6 E. 39th St., New York 16, N. Y.—silver anniversary convention and exposition, April 5 to 8, Chicago Coliseum.

The 10th Annual Midwest Power Conference—sponsored by the Illinois Institute of Technology, 3300 S. Federal St., Chicago, in cooperation with nine midwestern universities and nine engineering societies, April 7 to 9, Sheraton hotel, Chicago.

The 1948 Western Refrigeration Educational Exhibit and Conference—in conjunction with the Second Annual convention of the California Association of the Refrigeration Service Engineers Society, April 30, May 1 and 2, Palace hotel, San Francisco.

Water Cooling Towers
by C. H. Wheeler

"Blended Design" Cooling Tower Saves Building Appearance and Water

Arrow points to a Three Cell, C. H. Wheeler Water Cooling Tower with a masonry housing harmonizing with the architecture of a city skyscraper. The air conditioning system and cooling tower were added some years after the building was built, yet there is no "eyesore" atop this big office building. With 50 years' experience in cooling towers, we can design towers for your requirements with masonry, steel, wood or transite housings, erect them and guarantee results anywhere. Bulletin on request. Write for it today.

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REPRESENTATIVES IN MOST PRINCIPAL CITIES

Induced Draft Fans in top of Three Cell Cooling Tower indicated by arrow at left.

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STEAM CONDENSERS · AIR EJECTORS
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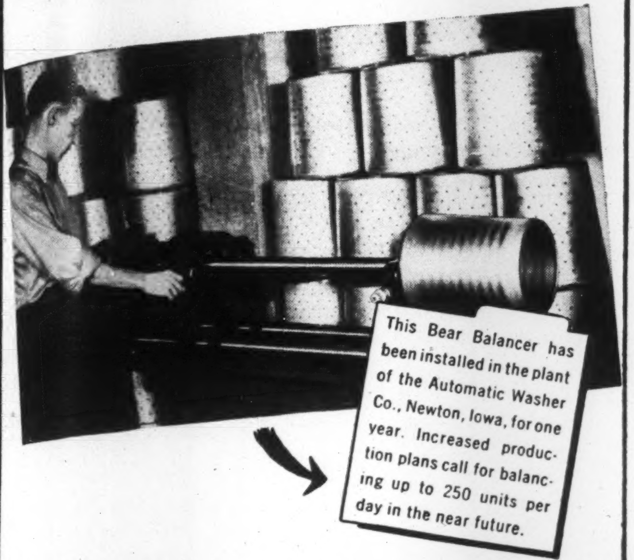
OF PHILADELPHIA

CASE REPORT No. 50 from a series of actual cases recording the successful application of BEAR DY-NAMIC BALANCING to Industry.



This Bear Balancer has been installed in the plant of the Automatic Washer Co., Newton, Iowa, for one year. Increased production plans call for balancing up to 250 units per day in the near future.

HEATING, PIPING and AIR CONDITIONING MEN!

YOU, Too, Can Gain These 3 Profit-Boosting Benefits of Dy-Namic Balancing as Reported by One Manufacturer.

SHORT BALANCING TIME increases Production. It takes just 2½ to 3 minutes to put these 10½" diameter baskets into perfect commercial Dy-Namic Balance. It takes just a few hours to train a Bear-Balancer operator. These 2 facts make it possible for the Automatic Washer Co. to work on a highly-increased production schedule.

CUTS WEAR to delicate machinery. In a Dy-Namically *un-balanced* state, these baskets vibrate considerably when revolved at their operating speed of 870 RPM. This oscillation naturally causes excess wear to spindle bearings, welding and other delicate parts of the machine. With Bear Dy-Namic Balancing this wear is cut because vibration is practically eliminated.

INCREASES CUSTOMER ACCEPTANCE of the finished product. When a washing-machine buyer notices the severe vibration and noisy performance of a machine containing Dy-Namically un-balanced rotating parts, sales resistance is hard to overcome. That is why the smooth operation and quiet performance of Dy-Namically Balanced bodies reflects in high customer acceptance of machines made by the Automatic Washer Co.

THERE'S A BEAR BALANCER FOR EVERY ROTATING BODY weighing anywhere from 2 oz. to 2 tons. Manufacturers in every line have successfully put Bear Balancing to the task of eliminating vibration, noisiness and below-par performance due to Dy-Namic un-balance. Our files most likely contain a case report covering your particular operation, too. Write for full details and the lastest Bear Industrial Balancing Catalog. Bear Mfg. Co., Dept. H-16, Rock Island, Ill.

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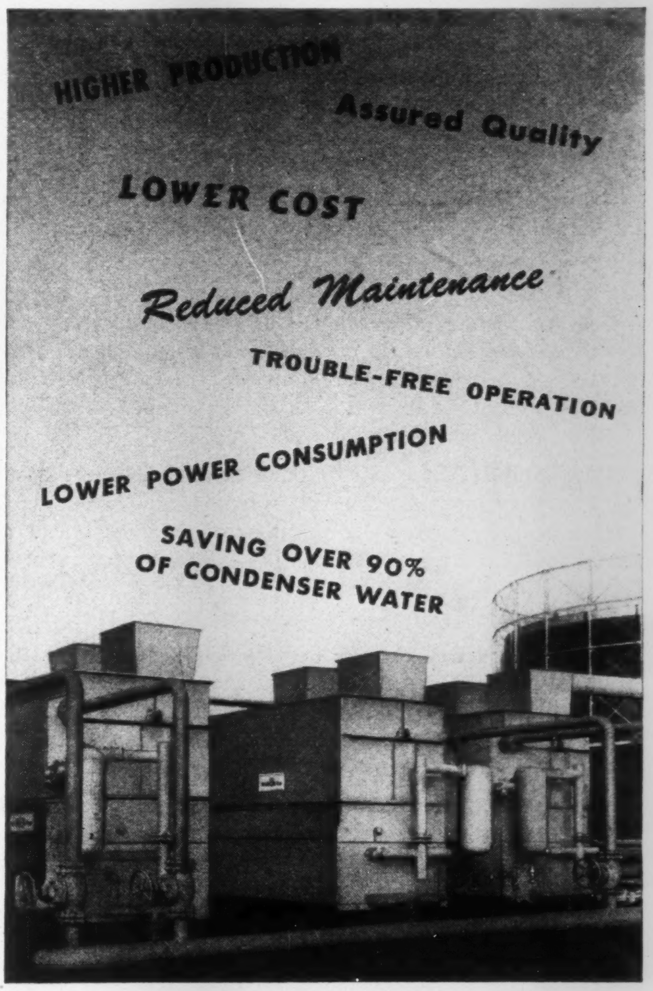

● Where processing or protective storage of products depends on refrigeration, install a Niagara Aero-pass Condenser. It assures year-round operation at minimum head pressure. It keeps the system clean of oil and dirt. It does away with scaling and clogging trouble on condenser tubes. It cuts condenser water consumption. It cuts refrigeration power costs. It increases production by giving extra refrigeration capacity.

Patented Features Include:

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"Oilout" to keep out oil and dirt.
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INDUSTRIAL COOLING • HEATING • DRYING
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HUMIDIFYING • AIR ENGINEERING EQUIPMENT

Second Engineering Progress Show, May 11 to 16, Franklin Hall, Franklin Institute of Pennsylvania, Philadelphia—sponsored by the junior members of the Engineers Club of Philadelphia and the Franklin Institute of the State of Pennsylvania.

National District Heating Association, 827 N. Euclid Ave., Pittsburgh 6, Pa.—39th annual meeting, May 18 to 21, Hotel Statler, St. Louis, Mo.

Heating, Piping, and Air Conditioning Contractors National Association, 1250 Avenue of the Americas, New York City—59th annual convention, June 1 to 5, Hotel William Penn, Pittsburgh.

Third Annual Home and Building Exposition, June 10 to 20, Pan-Pacific Auditorium, Los Angeles—the show is owned by the Los Angeles chamber of commerce and 14 major construction industry associations of southern California.

American Society for Testing Materials, 1916 Race St., Philadelphia—1948 annual meeting and Eighth Exhibit of Testing Apparatus and Related Equipment, the week of June 21 to 25, Book-Cadillac hotel, Detroit.

National Catholic Building Convention and Exposition, Inc., 185 N. Wabash Ave., Chicago, Ill.—building convention and exposition, June 30, July 1 to 3, Stevens hotel, Chicago.

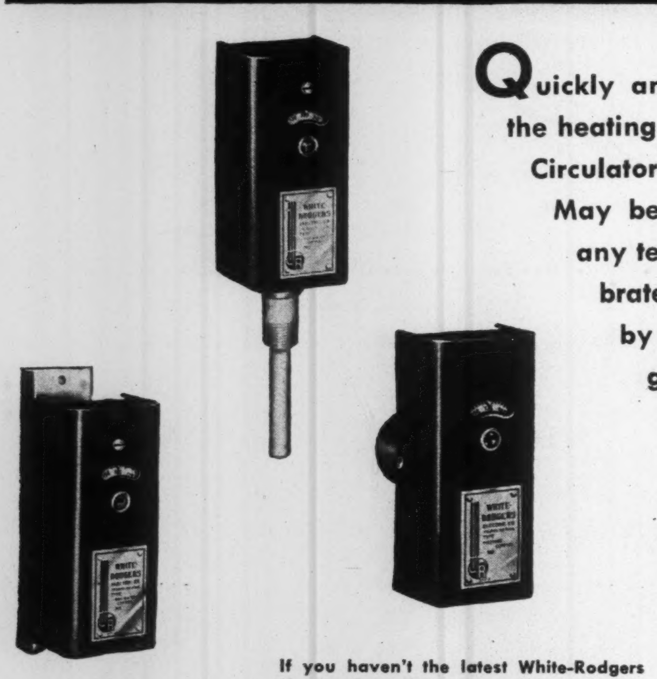
The 2nd International Store Modernization Show, July 6 to 10, Grand Central Palace, New York City. Invitations for admission can be obtained from exhibitors or from the Store Modernization Show, 40 E. 49th St., New York 17, N. Y.

American Chemical Society, Chicago section, 1513 S. Wabash Ave., Chicago 5—Fifth National Chemical Exposition, October 12 through 16, Chicago Coliseum.

Pan-American Engineering Congress, to be held late in 1948 or in 1949, South America—further information to be released by the Engineers Joint Council Committee on International Relations, 29 W. 39th St., New York City.

Ninth International Heating, Ventilating, and Air Conditioning Exposition, January 24 to 28, 1949, International Amphitheatre, Chicago—under the auspices of the American Society of Heating and Ventilating Engineers.

Sixth All-Industry Refrigeration and Air Conditioning Exposition, the week of November 17, 1949, Cleveland—sponsored by the Refrigeration Equipment Manufacturers Association.



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Quickly and easily installed — and as quickly adjusted to the heating need — White-Rodgers Hydraulic-Action Limit and Circulator controls are favored by installers everywhere. May be mounted at any angle or position, accurate at any temperature in dial range, with dials accurately calibrated in degrees Fahrenheit. Accepted as standard by leading manufacturers of heating equipment, they give you benefits of better and quicker installations, with more profit for you.

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RECENT TRADE LITERATURE

For your convenience in obtaining copies of these bulletins, see coupon on page 199. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending requests to Heating, Piping & Air Conditioning.

Allowable Working Pressures for Welding Fittings

No. 6779—A new and enlarged edition of the booklet, Allowable Working Pressures, has recently been issued by Tube Turns, Inc., 224 E. Broadway, Louisville 1, Ky. The booklet gives allowable working pressure for the company's welding fittings in five classes of piping. The tables are based upon the ASME Boiler Construction Code, 1946 edition, and the American Standard Code for Pressure Piping, ASA B31.1, 1942, as revised by supplement No. 2, ASA B31.1b, 1947. Subjects covered include gas, air, oil, and district heating piping. Also included are plant process piping and hydraulic machinery piping, which are not included in the code for pressure piping.

Anti-Rust Paint

No. 6780—"Rustrem," an anti-rust paint of "1000 plus one uses," is the subject of a new booklet issued by Speco, Inc., 3142 Superior Ave., Cleveland, Ohio. The booklet presents application directions and emphasizes that the paint can be applied directly over rusty surfaces without wire brushing or scraping. It is said to be ideal for use on marine and industrial machinery and on construction equipment, as well as water tanks and any metal surface subject to rust.

Ball Bearing Pillow Blocks for Light Duty Applications

No. 6781—Ahlberg Bearing Co., 3025 W. 47th St., Chicago 32, Ill., has published a four page folder, Economy Twins, on its series ED and EDR ball bearing pillow blocks for light duty applications. Both bearings are of the single row type with labyrinth type protective seals. Main feature of the EDR series is the use of a synthetic rubber moulded cushion to isolate vibration. The manufacturer recommends this unit for applications such as in air conditioning and ventilation equipment.

Boiler Blowdown Separator

No. 6782—Wilson Engineering Corp., Dept. HP&AC, 122 S. Michigan Ave., Chicago, Ill., has announced the publication of a new bulletin (No. 30) on boiler blowdown disposal problems and on the company's centrifugal blowdown separator. It includes discussions and recommendations for piping arrangements and separator installation dimensions. The manufacturer believes the subject matter to be of interest to numerous operators of small and medium size boiler plants who have the problem of disposing of boiler blowdown sludge and water and who are not permitted to discharge directly to a sewer without first arranging for venting of flash steam.

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Black & Decker
1/2" Junior Drill
$42.00

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IF you want a handy odd-job Drill to save time in your shop or on the job, a Black & Decker 1/4" Junior or 1/2" Junior Drill is the tool for you! These Drills are specifically built for shops that need a good low-priced drill for light-duty, intermittent service. They drive twist drills in piping, steel plates, ducts, vents, frames, braces and other metal parts. Drive wood augers for running pipe and ductwork through floors and walls. Drive Hole Saws for cutting clean, round holes in any material a hacksaw will cut. Drive wire wheel brushes and many abrasive attachments. See your nearby Black & Decker Distributor for details. Write for free catalog to: The Black & Decker Mfg. Co., 682 Pennsylvania Ave., Towson 4, Maryland.

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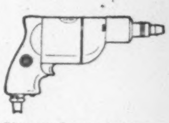
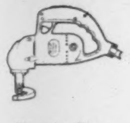
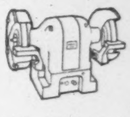
PORTABLE ELECTRIC TOOLS



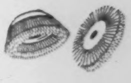
Electric Screw Drivers



Electric Shears



Bench Grinders



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HOW TO GET **PERFECT CIRCULATION** in Hot Water Radiators and Convectors

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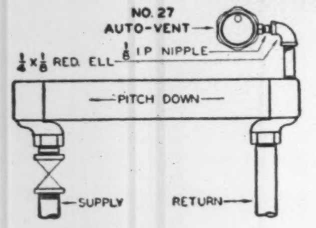
AUTO-VENT AIR ELIMINATORS REALLY DO A JOB!

As air accumulates in radiators or pipes, it is AUTOMATICALLY VENTED when you use these inexpensive No. 27s. Your customer gets better heating and saves fuel.

•AUTO-VENTS work equally well on convectors, baseboard radiation, panels, radiant heating coils, etc. — NO AIR CHAMBER REQUIRED. Good for pressures to 50 lbs. *See your jobber, or write us direct.*



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CHICAGO 41, ILLINOIS

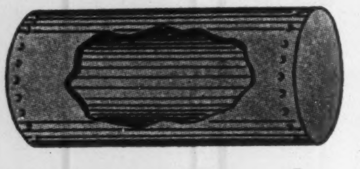
Calculator for Determining Valve Capacity

No. 6783—A valve capacity calculator for the "Kontrol-Motor" diaphragm valves and pressure regulators of Kieley & Mueller, Inc., North Bergen, N. J., has recently been announced. The calculator has been developed from laboratory tests and is based on rate of flow through the valve, static pressure and pressure drop through the valve, and valve size. Correction scales for steam quality and liquid and gas specific gravity are included, as well as a flowing temperature scale for gases. Of the circular slide rule type, the calculator is 8 in. in diameter and is offered with detailed instructions to design, construction, and process engineers and control valve users requesting it on their company letterheads.

Condensate Drainers

No. 6784—Multiport drainers for continuously removing large quantities of condensate from evaporators, heaters, separators, coils, or steam lines, are described in Publication 4340, recently issued by Cochrane Corp., 17th St. & Allegheny Ave., Philadelphia 32, Pa. Condensate is discharged through multiple port openings of a float controlled rotary valve. Continuous discharge is maintained at a rate determined by the height of condensate in the body. A single port design has been added to the line in the two smaller sizes for applications where condensate flow is only a small percentage of the steam flow. Capacities, dimensions, construction data, and list prices are given on standard and external cage models.

NEW LIFE! to Old Water Tanks



WITH APEX PERMANENT PORCELAIN LINING. Pitted or leaky water tanks can be restored to original usefulness by relining, applied in two coats approximately 1/4" thick—cures under water—has an affinity for lime—prevents corrosive and pitting action on metal—withstands temperatures up to 250° without cracking—adds years to life of tank.

RIDAL SERVICE CLEANS

CHEMICALLY STEAM & WATER SYSTEMS. Eliminate sludge and foreign matter from your entire plant safely and economically. We clean and restore to original operating efficiency CHEMICALLY such equipment as: TURBINES — CONDENSERS — STEAM FEED LINES — CONDENSATE RETURNS —WATER HEATERS—STEAM KETTLES—COOLING AND HEATING COILS — PREHEATERS — HEAT EXCHANGERS — EVAPORATORS — TRAPS OF ALL KINDS — ETC.

Consultation Service—Without Obligation

APEX Engineering Company
Central 2909
75 E. WACKER DRIVE CHICAGO, ILL.

AIR-FLO MODEL A-555
AUTOMATIC SHUTTER
WEATHER-SEALED

leads the field in features!

FRONT VIEW--CLOSED

There is every reason why you should use AIR-FLO shutters on your jobs. New heavy reinforcement strip adds strength and long life to the louvers, assures quiet operation and perfect counterbalance, prevents rattling. Aluminum louvers open fully, permitting capacity fan operation. Deep shroud protects shutter from high winds. Tie-rod, brackets and bearings inside frame, not exposed to weather. Special finish resists corrosion. Many other features. Write for illustrated catalog 42-D of the complete AIR-FLO line.

AIR CONDITIONING PRODUCTS CO.
2340 W. LAFAYETTE BLVD. DETROIT 16, MICH.

Direct Fired Air Heaters

No. 6785—Airtherm Mfg. Co., 711 S. Spring Ave., St. Louis 10, Mo., has issued a new bulletin (No. 802-12-47) on its line of direct fired air heaters which are available in floor, horizontal, and inverted suspension models. In addition to describing and illustrating the design and construction features of these units which are either gas or oil fired, the bulletin provides gas and oil piping diagrams, typical specifications, dimensions, and capacity tables.

Drilling and Spot Welding Aluminum

No. 6786—While good results in drilling aluminum may be obtained with standard twist drills, optimum results can be obtained with much higher rotational speeds, heavier feeds, and drills of special design, according to a feature article in the Vol. 1, No. 6 issue of the house organ published by Reynolds Metals Co., 2500 S. Third St., Louisville, Ky. The article also covers drill materials, designs, and lubrication. Some of the important phases of spot welding aluminum are covered in another brief article in this issue.

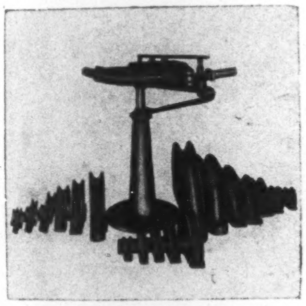
Evaporative Condensers

No. 6787—Evaporative condensers for "Freon" and ammonia are covered in a new bulletin (No. 17) issued by Baltimore Aircoil Co., 715-17 W. Pratt St., Baltimore 1, Md. The model U evaporator, available in sizes from 10 to 100 tons, is designed for either indoor or outdoor

Use "American" PIPE BENDING MACHINES . . .

for fast, dependable bends

Radiant HEAT Pipe Bending is simple, accurate with good equipment . . . hand or motor-powered machines available . . . up to 8" capacities.



The Hand-powered "American" A-30

Bends ½" to 2" standard pipe sizes to a radius of 5 to 1, up to 180°. Special radii within these sizes supplied on request. Usual radiant heat bends for 1¼" at 6" & 9" radii can be supplied. Special radius supplied on request.

- Average bend takes only 60 seconds!
- Versatile—bends cold pipe, conduit and tube, copper and brass I.P.S. without crimping.
- 12,000 in use all over the world.

BENT ONCE — BENT RIGHT ON "AMERICAN" PIPE BENDING MACHINES

American PIPE BENDING MACHINE Company INC.

Factory and Main Office: 17 Furnace St., Poultney, Vermont

Out Goes Bad Air!

For more production . . . better morale . . . *install* Swartwout Ject-O-Valve

● This modern powered roof ventilator forces out masses of heat, smoke and fumes from foundry, glass plant, forge shop and other work rooms, clears the atmosphere for greater comfort and more efficient operations. Ject-O-Valve eliminates air-contaminating elements before they spread—blasts them *straight up* into the outer air and draws *fresh* air from outer walls where it enters. Force from the powerful propeller fan holds pivoted top open, keeps out weather. Top closes tight—weather-proof—when motor stops.

Carefully engineered in five sizes; varying motor-fan ratings to give you a selection of 28 different capacities. Hinged top permits easy access for servicing.

Swartwout *AIRMOVER* for "open roof" ventilation

For situations where ventilation is *general,* requiring removal of unwanted elements over a wide area, the gravity type AIRMOVER practically opens your roofs to the sky . . . with full weather-protection but minimum air-flow resistance. *Write for Bulletin 324.*

The Swartwout Company
18568 EUCLID AVENUE • CLEVELAND 12, OHIO

Swartwout *Controlled* Air Circulation

EQUIPMENT FOR EFFECTIVE ECONOMICAL VENTILATION OF INDUSTRIAL BUILDINGS

QUALITY *always wins!*

MARTOCELLO
Products are fully
DEPENDABLE

ATOMIZING SPRAY NOZZLES
(1930) ⅜" P.S. MALE
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⅜" P.S. FEMALE
(1920)
(2300) ⅛" P.S.
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SPRAY POND NOZZLES
(1370)
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CONDENSER WATER DISTRIBUTORS
AIR VENT

ATOMIZING SPRAY NOZZLES, SPRAY POND NOZZLES, and CONDENSER WATER DISTRIBUTORS

For Vertical Shell and Tube Ammonia Condensers

ALL MARTOCELLO SPRAY NOZZLES are manufactured with precision and of a design which has been thoroughly tested for maximum results and durability. They are guaranteed to give satisfaction. Successful, efficient results depend largely upon selecting the proper number, type and size of Nozzles suitable for your installation.

THE MARTOCELLO CONDENSER WATER DISTRIBUTORS are now used as standard equipment by Progressive Refrigerating Engineers in solving their Manpower problem, because they require no attention and assure users of the lowest Condenser Operating Pressures and Minimum Power Cost.

It will pay you to consult us. WRITE or WIRE for further information.

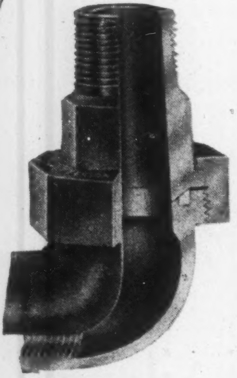
Jos. A. Martocello & Co. 229-231 NORTH 13th STREET
PHILADELPHIA 7, PA

"Serving the Ice Industry Since 1916" . *"There is no Substitute for* MARTOCELLO QUALITY"

Easy to work with . . .

JEFFERSON

Unions



Sure they're easier to work with! Jefferson Specialty Unions, such as this male and female union ell are constructed for maximum ease of installation while at the same time affording permanent protection against leaky joints and consequent annoying and expensive shutdowns. Once they're installed you're certain of a lifetime connection because of the recessed brass seating feature. You can't dislodge it by screwing pipe ends in too far and it gives a tight, leakproof joint. Get the details on our complete line. Write now!

JEFFERSON UNION CO.

601 West 26th Street
New York 1, N. Y.

Lexington 73, Mass.
Lockport, N. Y.

duty. The new model CPE unit, available in 9 sizes from 10 to 50 tons, is suitable for outdoor use only and is said to be ideal for air conditioning and commercial refrigeration applications due to the characteristics of the propeller fan. When the air resistance through the condenser is decreased (during winter dry operation), the fan is said to handle about 50 percent more air with a subsequent drop in brake horsepower on the fan motor. This increased air volume is said to reduce the drop in capacity normally encountered in dry operation.

Fire Protective System for Wellways

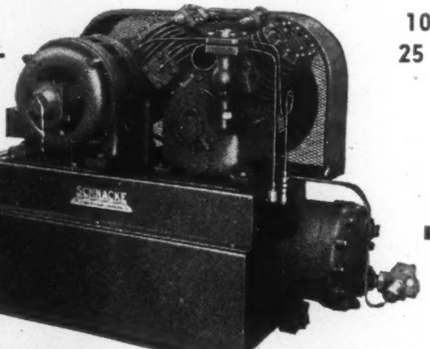
No. 6788—A 16 page illustrated booklet, The Exhaust-Water Spray Fire Protective System for Wellways, which describes in detail this new method of combating the spread of fire and fumes through burning buildings, has been published jointly by Otis Elevator Co., Westinghouse Electric Corp., and Grinnell Co., Inc. The three firms cooperated in developing the technique using a ventilation exhaust system and a curtain of water. Copies of the booklet are available from the Otis Elevator Co., 260 11th Ave., New York City 1.

Forced Hot Water Heating System

No. 6789—H. A. Thrush & Co., Peru, Ind., has issued a new bulletin (Form FC-148) on the company's forced circulating, flow control system of hot water heating. The booklet, prepared especially for the consumer, contains numerous illustrations and diagrams and discusses the various applications of the system and its components.

F-C MODEL

10 TO 25 H.P.



SCHNACKE
COMPLETE
CONDENSING UNITS

For Air Conditioning and Refrigeration

SCHNACKE Compressor has replaceable, refrigerant-cooled steel cylinder sleeves, balanced forged crankshaft, sealed crankcase, complete pressure lubrication, and many other advanced features.

Condenser is ASME approved, fin tube, cleanable type, mounted in sturdy base. Water control valve and pressure control installed. T-C Models 5 to 15 H.P. available. Models less condenser, from 5 to 50 H.P.

Our new foundry now makes deliveries on most models possible in one to two weeks.

Write SCHNACKE, INC., 1020 E. Columbia St., Evansville, Ind., for complete details.

SCHNACKE, INC.

"Freon-12" Compressors

No. 6790—The recently developed "New Eclipse" compressors for "Freon-12" are described and illustrated in Bulletin 100-D released by Frick Co., Waynesboro, Pa. While similar to the company's former machines, the new and improved units are said to incorporate many refinements. Standard capacities on air conditioning work range from 17½ to 53 tons. Overall dimensions, sizes, capacities, speeds, controls, and drives are covered.

Hot Gas Defrost System

No. 6791—A new four page bulletin on the company's hot gas defrosting system utilizing the "Defrostolator" has been issued by Tenney Engineering, Inc., 26 Avenue B, Newark 5, N. J. This bulletin, designated as TAD-48, shows a diagram of this system, indicating both the refrigeration and defrost cycles. Information is given on the operation and the variations of functions featured in the system. According to the company, this system is a simplified method for quickly defrosting low temperature evaporators without excessive temperature rise. It is also said to be independent of the condensing unit so that capacity and speed of defrosting are not limited by the size of the condenser.

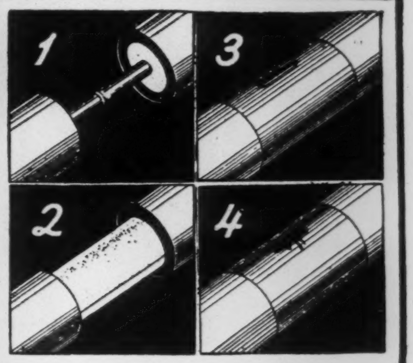
Indicating Controllers

No. 6792—Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa., has published a new seven page catalog covering the model C "Micromax" indicating controllers. This publication lists complete specifications in tabular form for all of these controllers—whether they are potentiometers or wheatstone bridges; whether

Positive Protection

BUILT-IN at FACTORY

For all your underground and exposed piping jobs you'll like DURANT Pre-Sealed Insulated Pipe. It is waterproof . . . reduces installation costs to a minimum . . . eliminates electrolysis and corrosion . . . requires very little trenching and field work . . . avoids extra cost of waste and breakage . . . comes to you ready to install. In short, D.I.P. is the *perfect pipe* for this type of job. Investgate D.I.P.! Write for details today.



4 Simple Steps

1. Field joint ready for inspection. 2. Joint covered with standard pipe insulation. 3. Durant joint casing in place ready for asphalt. 4. Asphalt poured in slot making a perfect seal.

Ready to Install

PRE SEALED

FOR STEAM
HOT WATER
REFRIGERATION
Trade Mark

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Durant
INSULATED PIPE CO.
1015 Runnymede St.
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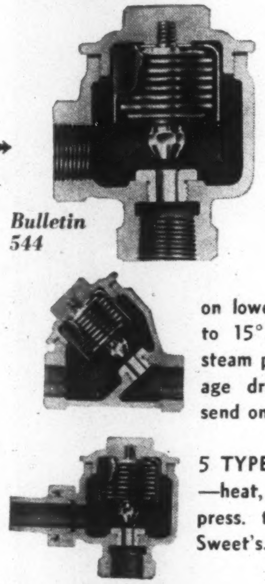
The ORIGINAL Pre-sealed Insulated Pipe

How to Keep Equipment FULL of Live Steam



Prompt and full drainage of condensate and venting of air and non-condensible gases are among the most important factors in maintaining maximum heat in coils, kettles, etc. Two reasons why Nicholson thermostatic traps prove superior in test after test: (1) operate on lowest temperature differential, 5° to 15°, depending on trap size and steam pressure. (2) 2 to 6 times average drainage capacity. We'll gladly send one for testing

5 TYPES FOR EVERY APPLICATION —heat, power, process; size ¼" to 2"; press. to 225 lbs. Bull. 544 or see Sweet's.

W. H. NICHOLSON & CO.
198 OREGON STREET
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Valves ★ Traps ★ Steam Specialties

PHOENIX
Drop △ Forged
FLANGES

A COMPLETE RANGE OF STYLES

Welding neck, slip-on, socket, threaded, lap joint, blind, hillside, boiler spuds . . . the Phoenix line includes all these types. They're drop forged of mild steel perfectly suited to machining and welding and they meet ASA requirements and ASME and ASTM specifications in every case. The Phoenix Flange Catalog shows the full line. Request your copy today.

PHOENIX MANUFACTURING COMPANY
JOLIET, ILLINOIS △ CATASAUQUA, PA.

Smokestacks
Tell the Story

"Observation of the smokestacks after the installation of *Brownell Stokers* in this city shows a decided difference," said the smoke inspector of a large city in a letter he wrote us.

"Savings in fuel, reduction of labor cost, and freedom from smoke are a source of satisfaction to the owners. More than that, it is an evidence of good citizenship for an owner to co-operate with the Smoke Abatement Commission for the betterment of the city."

You can benefit yourself and the community by using Brownell Stokers. Get complete information. If you don't know the name of our nearest agent, ask us.

Brownell Matched Unit—the happy combination for fuel economy and smoke abatement.

The BROWNELL Company
408 N. FINDLAY ST., DAYTON 1, OHIO

they measure temperature through use of thermocouples, "Rayotubes," or "Thermohms"; and whether they provide two-position, position adjusting, or duration adjusting type control. Illustrations show installation and interior views of these instruments. In addition, standard ranges are listed.

Low Carbon, 8½ Percent Nickel Steel

No. 6793—According to the International Nickel Co., Inc., 67 Wall St., New York 5, N. Y., the increasing use of sub-zero temperatures in many industries has stimulated much interest in the development of materials resistant to brittle behavior at low temperatures. This has resulted in the development of a low carbon steel containing 8.00 to 9.00 percent nickel which is the subject of a paper, Some Properties of Low Carbon 8½ Percent Nickel Steel, by T. N. Armstrong and G. R. Brophy. Both authors are with the company which has reprinted the paper.

Maintenance Check Chart for Electrical Equipment

No. 6794—A maintenance check chart for electrical equipment including motors, control equipment, wiring, fuses, transformers, and lightning arresters is now available from Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa. Recommendations as to the frequency of inspection, cleaning, lubrication, and various adjustments are given.

WHAT'S NEW?
in Welding Rings

TUBE-TURN
GROOVE TYPE WELDING RINGS
WITH KNOCK-OFF SPACER PINS
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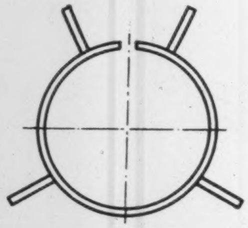

GET THIS FOLDER

Tube-Turn Groove Type Welding Rings with Kick-Off Spacer Pins: A folder of data about a major new development for better pipe welding—a completely engineered welding ring for exact root gap spacing and complete penetration. For complete information get this folder. Mail the coupon.

TUBE-TURN WELDING FITTINGS AND FLANGES
District Offices at New York, Philadelphia, Pittsburgh, Detroit, Chicago, Houston, Tulsa, San Francisco, Los Angeles

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Please send folder, "Tube-Turn Groove Type Welding Rings".
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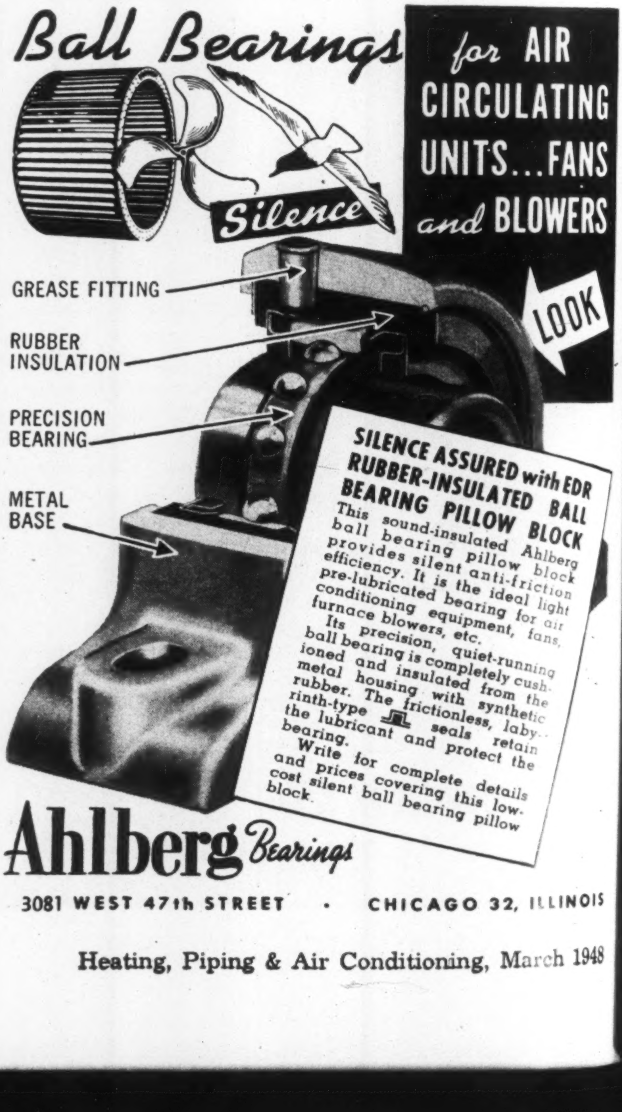

SILENCE ASSURED with EDR RUBBER-INSULATED BALL BEARING PILLOW BLOCK

This sound-insulated Ahlberg ball bearing pillow block provides silent anti-friction efficiency. It is the ideal light pre-lubricated bearing for air conditioning equipment, fans, furnace blowers, etc.

Its precision, quiet-running ball bearing is completely cushioned and insulated from the metal housing with synthetic rubber. The frictionless, labyrinth-type seals retain the lubricant and protect the bearing.

Write for complete details and prices covering this low-cost silent ball bearing pillow block.

3081 WEST 47th STREET • CHICAGO 32, ILLINOIS

Moisture Measuring Equipment

No. 6795—A 28 page bulletin (No. 2164-92), published by American Instrument Co., Inc., Silver Spring, Md., describes the company's line of electric hygrometer equipment suitable for the more exacting industrial and laboratory applications. Among other devices, the booklet lists a tiny sensing element that is said to respond within a fraction of a second to changes in relative humidity as small as 0.1 percent. This element, according to the manufacturer, measures relative humidity with an accuracy of ± 1½ percent when properly used with suitable equipment. Also included are data on various industrial and laboratory applications, selection charts, diagrams, calibration curves, and information on other instruments.

Oil Burner Combustion Control

No. 6796—Type SA "Robot-Eye" is an electronic oil burner combustion control developed by General Power Plant Corp., 381 Fourth Ave., New York 16, N. Y., for use in apartments, hotels, office buildings, and industrial plants. According to the manufacturer, it is a simple, inexpensive, and practical device for maintaining CO_2 at a uniformly high value without smoke formation. It is designed and built particularly for the control of rotary cup type oil burners and may be used with steam or pressure atomizing burners using No. 5 or No. 6 fuel oil. In the device, "haze density" is measured by a photoelectric cell and the minute current generated is used to control the admission of air to the furnace. It is described and illustrated in bulletin SA-2-47.

KEY-TITE

THE KEY TO SEALING PIPE JOINTS AND GASKETS *Permanently!*

Pipe joints once sealed with Key-Tite do not leak, yet they can be easily opened because Key-Tite does not freeze the connection. It contains no lead or lead substitutes and does not affect the taste, color or odor of potable liquids. Key-Tite prevents leaks on all lines carrying water, gas, low-pressure, steam, compressed air, etc.

KEY-TITE
WATER PROOF
PIPE JOINT
COMPOUND

SEND FOR FREE SAMPLE: Test Key-Tite in your own plant at no cost to you.

KEY COMPANY
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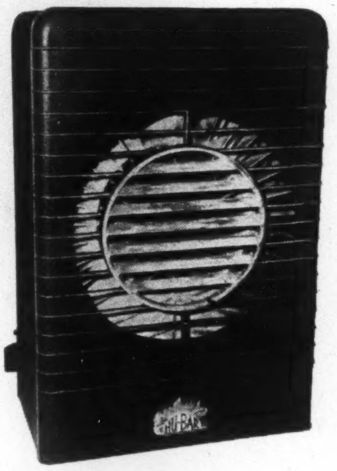
KEY Company

BEAUTY . . . STYLE . . .
DESIGN . . . EFFICIENCY



Beauty in design and sound engineering protected by 18 patent points combine to make this the heating sensation of the year. Available in space and unit heaters.

One piece cast aluminum alloy heat exchanger combustion chamber and patented air foil eliminates expansion and contraction noises. For use with natural gas, L.P. gas or manufactured gas.

Only the best of standard valves, switches, etc., used on this model.

The most outstanding advance in heat circulation since the development of forced air heating.

Distributorships Available
Write or Wire Today for Full Details

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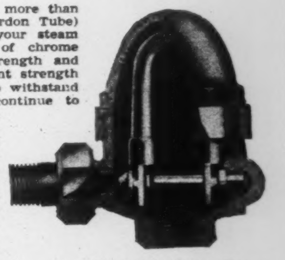
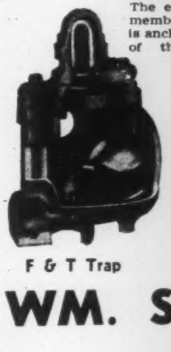
HAINES TRAPS
HAVE PROVEN THEIR
Merit Simplicity Durability

HAINES TRAPS have been manufactured for more than fifty years in which the Thermostat (or Bourdon Tube) has been perfected and is as accurate as your steam gauge. The operating member is made of chrome molybdenum steel tubing which assures strength and endurance. Haines Traps, due to the inherent strength of their design and construction, are able to withstand the stress of excess pressures and still continue to function. In Haines Traps, the thermostat is subjected to the lower temperature of the return line. This permits of greater valve travel and a more positive draining of the unit to which the trap is attached. The thermostatic member is mounted vertically on a horizontal valve motion and closes the valve piece against the flow of steam. The end of the thermostatic member opposite the valve is anchored, hence the travel of the thermostat either opens or closes the valve. Due to the fact that the Thermostat is mounted outboard the valve piece, the Haines Trap controls a large valve opening, which enables it to handle large volumes of air and water and prevents it from becoming ineffective from scale or other foreign matters.



Vento Radiator Trap

Haines Float & Thermostatic Traps are built for any low pressure installation up to 15 lbs. in the ¾" and 1¼" sizes and 30 lbs. in the 1" size. They cannot become air bound and the Haines underslung principle insures safety . . . no danger of building up a pressure.



F & T Trap

WM. S. HAINES & CO.
1012 Wood Street
Philadelphia 7, Penna.

PIPETTE Stik
PIPETTE Stik
GOING OVER BIG!
"Reddy"

Always "Reddy" for Instant Use

PIPE JOINT COMPOUND
in Stick Form

for Pipe Installation and Maintenance

WON'T DRY OUT
•
HANDY AS A PENCIL

POSITIVE SEAL *for*

- Oil
- Butane
- Propane
- Freon
- Air
- Water
- Gasoline
- Steam
- Acid
- Gas
- Brine
- Refrigerants

NO MESS BRUSH WASTE

Contains No Lead.
Contains No Injurious Ingredients

Order from your Supplier or write us for FREE SAMPLE

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BE SURE YOU SEE THIS NAME!
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TRADE MARK
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SENTRY GAUGE CO
On Guard 24 hours a Day!

IMITATED... BUT NEVER DUPLICATED

Like the proverbial "Monkey sees, monkey does" our famous AT-A-GLANCE tank gauges have imitators. You can rest assured however, that for guaranteed quality and lasting satisfaction, there is nothing on the market quite like our original. Be sure — before you buy. Write for literature and descriptive details of important features.

KRUEGER *Sentry* GAUGES
GREEN BAY • WISCONSIN

Packaged Air Conditioner

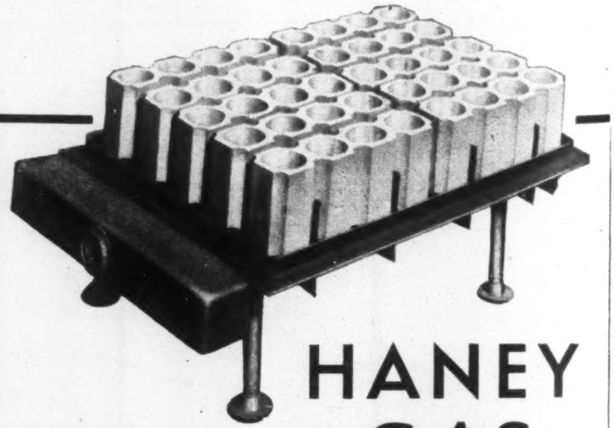
No. 6797—The design and construction features of the new packaged air conditioner offered by Worthington Pump and Machinery Corp., Harrison, N.J., are fully set forth in an unusual bulletin recently issued. Available in three and five ton units and with a water cooled condenser, the conditioner is illustrated in color on transparent plastic pages. Various cross-sectional views are obtained by turning the pages and an identifying color and numbering system is used to correlate the parts illustrations with the descriptive material.

Pipe and Stud Extractors

No. 6798—A four page bulletin on the company's pipe and stud extractors has been released by Reps Tool Co., Inc., 94 Allyn St., Hartford 3, Conn. Illustrated for the first time is the company's master set No. 210 which is packed in a special metal box. This set includes a selector plate for determining the size extractor required for a broken pipe stud or screw. Drill sizes for drilling out stud and screw centers prior to removal with the extractor are also shown. The extractors are made in 10 sizes to handle pipe from $\frac{1}{8}$ through 2 in. and to handle screws and stud sizes from $\frac{3}{8}$ through $3\frac{1}{2}$ in.

Pipe, Tubing and Fittings of Stainless Steel

No. 6799—Tables showing the properties of the most commonly used types of stainless steel are featured in a new bulletin describing the stainless steel pipe, tubing,



HANEY GAS BURNERS

WRITE TODAY FOR COMPLETE INFORMATION

The Haney venturi gas burner, vertical type shown above is your answer to heating problems in commercial, domestic or industrial installations. It's designed to provide the maximum heat with a minimum of fuel consumption. High quality manufacture guarantees a burner of outstanding performance free from upkeep, repairs or replacement costs. Available for LP gases. Please write for literature.

HANEY GAS BURNER AND ENGINEERS
909 South Myrtle Avenue Monrovia, Calif.

and fittings offered by John B. Astell & Co., 90 W. Broadway, New York 7, N. Y. The bulletin discusses applications in various industries where different types of corrosion are encountered. Also tabulated are the dimensions, including wall thicknesses, of the company's light wall, standard, and extra heavy grades of stainless pipe which can be suppled in any size for use with the company's fittings.

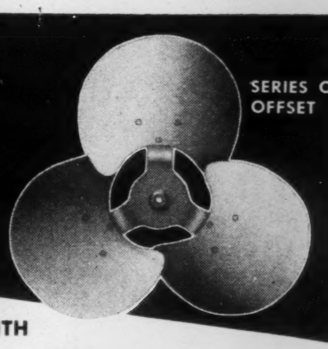
Radial Thrust Roller Bearings

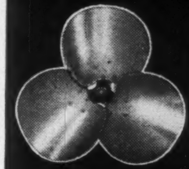
No. 6800—A new 16 page illustrated booklet (No. 2196) on "DE" radial thrust, self contained, preadjusted roller bearings has been issued by Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill. These bearings are of the angular contact (radial thrust) type with concave rollers operating between convex raceways. Information is given on dimensions, weights, bearing capacities at given revolutions per minute, shaft fit tolerances, and housing fit tolerances. Data for calculating the required bearing capacity for different types of machinery are included.

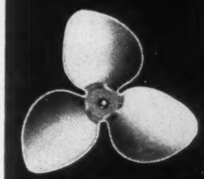
Salvage of Castings by Welding

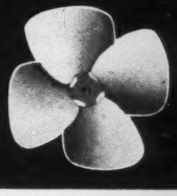
No. 6801—Welding procedures for salvaging cast iron, bronze, aluminum, and malleable iron castings, with emphasis on machine shops and foundries of heavy machine builders, are set forth in an illustrated two page bulletin recently issued by Eutectic Welding Alloys Corp., 40 Worth St., New York 13, N. Y. How to seal leaks and cracks, treatment of light and heavy castings, and the application of special alloy welding rods for use at low base metal temperatures are described.

"QUIET" EFFICIENCY IN YOUR VENTILATING EQUIPMENT









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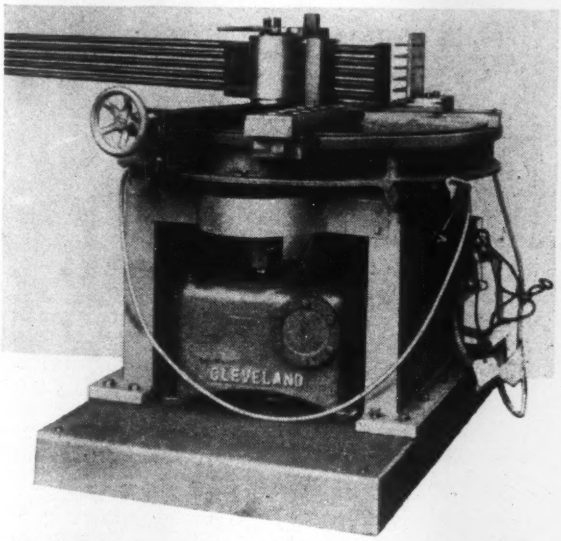

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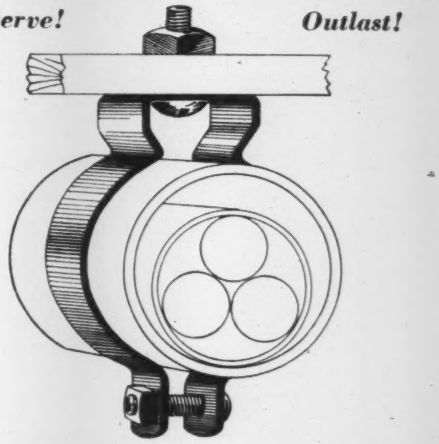

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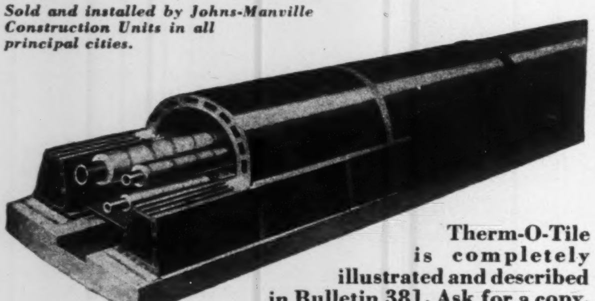

Therm-O-Tile is completely illustrated and described in Bulletin 381. Ask for a copy.

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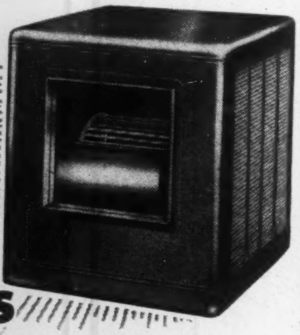

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Sheet Metal Brakes, Shears Benders, Punches, Rod Parters

No. 6802—A new edition of the 40 page "Di-Acro" catalog has been released by O'Neil-Irwin Mfg. Co., Lake City, Minn. The booklet contains illustrations and specifications on all of the company's precision machines for duplicating parts or pieces. These include brakes, benders, rod parters, shears, punches, etc.

Stainless Steel Piping

No. 6803—A new booklet, Stainless Steel Piping—Why and Where to Use It, by J. D. Mattimore, chief engineer, product and research division, Tube Turns, Inc., 224 E. Broadway, Louisville 1, Ky., discusses five major reasons for using stainless steel piping and covers the types of stainless steel available. Standardization of pipe and fittings, selection of pipe joints, and fabrication by welding are also covered. The booklet, available from the author's company, has been reprinted from a series of three articles recently published in HPAC.

Underground Steam Pipe Units

No. 6804—The story of how Pittsburgh's cultural, educational, and medical institutions are linked by a central heating system is told in a new 12 page bulletin, one in a series of case histories on central heating, issued by Ric-wiL Co., Union Commerce Bldg., Cleveland 14, Ohio. Information is given on peak loads used in sizing pipe lines and on how the company's insulated pipe units were used to extend a steam line 3000 ft.

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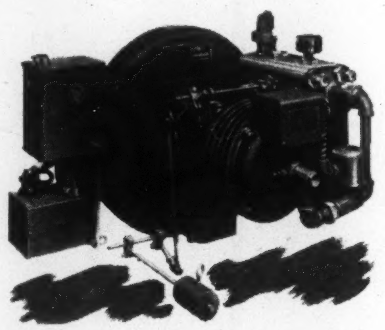

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Unit Heater for Steam and Hot Water

No. 6805—Three models of the diffusion type unit heater offered by Merchant & Evans Co., 2035 Washington Ave., Philadelphia 46, Pa., are described and illustrated in a new bulletin. Designed for both low pressure steam and hot water, the units feature rounded fronts and heater elements of copper finned tubing. Capacities of the three models are 147, 312, and 754 EDR steam. Suggested piping installation and roughing-in diagrams are included.

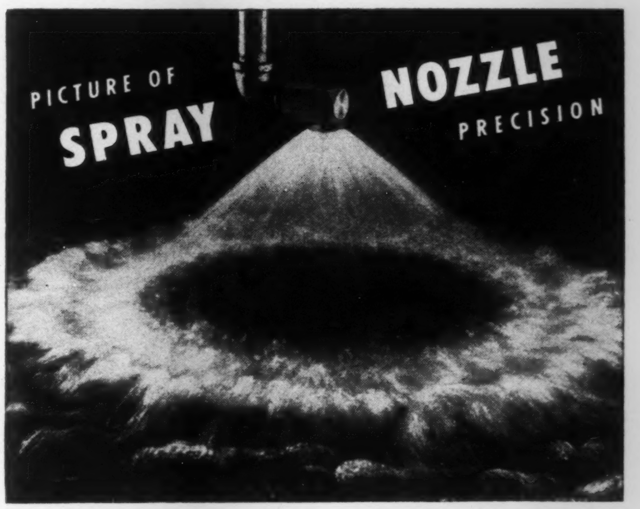
Use of Air Diffusers in Climatic Hangar

No. 6806—The new climatic hangar at Eglin Field, Florida, is used by the Proving Ground Command of the U. S. Army Air Forces as a central testing laboratory where new aircraft and equipment are subjected to climatic conditions similar to those encountered in operational flying. It is described in a feature article of the Vol. 4, No. 1 issue of the house organ published by Anemostat Corporation of America, 10 E. 39th St., New York 16, N. Y. Also described is the use of the company's air diffusers in handling air from the elaborate conditioning system.

Welding Cables and Connections

No. 6807—A new two page bulletin, entitled Causes and Cures for Hot-Running Welding Cables and Connections, has been issued by Tweco Products Co., Wichita 1, Kans. The bulletin provides recommendations for the proper use of welding cables and connections.

PICTURE OF SPRAY NOZZLE PRECISION



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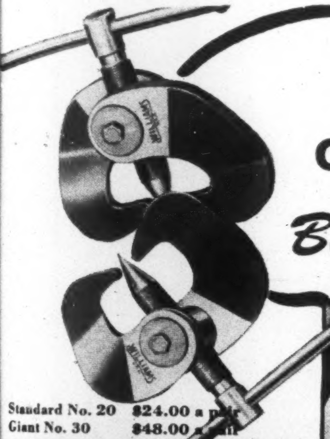

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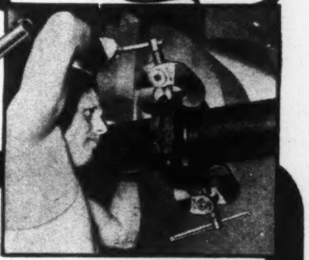

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